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MECHANICAL DENTISTRY

IN

GOLD AND VULCANITE:

ARRANGED WITH REGARD TO

THE DIFFICULTIES OF THE PUPIL, MECHANICAL ASSISTANT, AND YOUNG PRACTITIONER.

BY

F. H. BALKWILL, L.D.S., M.O.S.

LONDON:
J. & A. CHURCHILL, NEW BURLINGTON STREET.
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PREFACE.

THE object of the author of this work has been not to supplant any of the text-books on Dental mechanics at present in use, merely to supplement them. It seemed to him that, having filled the position of pupil, mechaniçal assistant, and young practitioner, several difficulties had occurred to him which would be likely to happen to others following the same path. Most of the chapters appeared in the 'British Journal of Dental Science,' which will explain to some extent the order in which the subject matter is arranged. The method of packing vulcanised rubber directly on the model was fresh; experience has modified some of the methods then used. That described at page 54, has not been found to work so well in practice as that at page 68. Not that practice has shown any defect in the results, but that the method at page 68 has answered equally well in most cases with only one cooking. The introduction consists principally of two papers which were read before the Odontological Society in 1866 and 1869, which are reprinted by their kind

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permission. After fourteen years' practice since the part in the introduction on the best form for dental substitutes was written, the author cannot say that the arrangement and shape there described have been rigidly carried out in every case, but the knowledge which was gained in comparing the forms of the teeth in the lower animals with their functional uses has been of immense service to him in practice, and when a case has been met with where, from feeble muscular tone, there has seemed to be no power to eat with artificial teeth, a close observance of the conditions indicated in this part has often led to marked success.

As an apology for the rest of the introduction, which to some may seem out of keeping with a practical work, the author can only say that he believes a close observance with the methods of nature will often give hints to the practical mechanic, even if it does not raise the dignity of his work.

PLYMOUTH.

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CONTENTS.

PAGE

PREFACE iii

INTRODUCTION.

What is a tooth?—Comparative view of the mechanical conditions and functions of some of the lower animals.—Consideration of those of the natural teeth of man.—Suggestions for carrying out these conditions in artificial dentures xi

CHAPTER I.

ON REGULATION PLATES.

Method of packing vulcanite regulation plates on the model.—Mr. B—'s case, Fig. 1.—First molars extracted to make room for pushing back bicuspids.—Method of tying in plate, Figs. 2 and 3.—Method of drawing back lateral and canine.—Method of pushing lateral forward.—Time to be allowed between visits.—Amount of pressure desirable.—Reasons for drawing a tooth forward instead of pushing it.—Method of drawing forward lateral, Fig. 4.—Method of pushing out a solitary lateral.—Method of tying canines, Fig. 5.—Method of pressing back bicuspids to make room for canines after extraction of first molars, Figs. 6 and 7.—Case of the Miss D—'s twins.—Amount of space gained.—Time of removing first molars to be seriously considered.—Measurements to show that the width of arch between the bicuspids increases between the ages of ten and twelve, Fig. 8.—Underhung mouths, consideration of the conditions.—Case of Miss M—.—Method employed, Figs. 9 and 10.—Method of bringing into place an outstanding incisor above or below, Fig. 11.—Retaining caps 1

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CHAPTER II.

ON ADDITIONS AND REPAIRS.

PAGE

Method of taking impressions for repairs in gold.—Method of adding to an old gold plate, Fig. 12.—To add single tube teeth to an old gold plate.—To solder on sand.—To add single flatbacks to an old gold plate.—To repair a vulcanite piece, Fig. 13.—Necessity of cleanliness.—To add single teeth.—To refit and raise the bite of an old vulcanite lower.—Mr. R—'s case, Fig. 14.—To add vulcanite to old gold piece; consideration of the modes of attachment between the two materials; cases given, Figs. 15, 16, and 17 . . 20

CHAPTER III.

VULCANITE DENTURES.

Miss H—'s case.—Method of packing vulcanite on a model of a cleft palate, using gum sectional blocks, Figs. 18, 19, 20, and 21.—On metallic strengtheners for vulcanite work.—To make a lower with vulcanite to hold the back teeth and a gold bar in front.—To bend a half-round gold wire as a strengthener for a vulcanite lower.—Gold strengthener for upper vulcanite pieces, Fig. 24.—Advantage of vulcanite for lower pieces.—Method of making small vulcanite lowers.—Method of making ditto, carrying the masticating teeth with a bar behind the front teeth.—Ditto, ditto, with a few front teeth, by packing directly on the model.—Larger pieces made on a tin cast.—Exceptionally difficult cases packed on the model.—Mrs. H—'s case, Fig. 25.—Mr. H—'s case, Fig. 26.—When stumps have to be covered pack on the model, Mr. B—'s case.—Consideration of the merits of gold and vulcanite for uppers—Of springs *versus* suction sets.—With spring sets it is best to put a gold upper plate; exceptions; case of Mrs. F—.—Method of packing suction upper vulcanite piece in two cookings.—Mrs. B—'s case, Figs. 27, 28, and 29 34

CHAPTER IV.

SUCTION UPPERS.

The principle of suction considered.—Illustration of a thimble sucked on to the hand; of two pieces of plate glass adhering by atmospheric pressure; of a small coin pressed upon the moist palm.—Results

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PAGE

contrasted, inference drawn.—Use of suction chamber.—Suction discs.—A good fit on an edentulous gum a self-regulating suction chamber, Fig. 30.—Classification of suction pieces, as, firstly, where the whole of the alveolar ridge may be covered; secondly, where the front teeth have to be set to the natural gum.—Three difficulties enumerated in connection with the first class of suction uppers.—Consideration as to when a lower piece is necessary to make an upper suction keep up.—Relative positions of upper and lower incisors.—Importance of due consideration of this in making suction pieces.—Tilting forward by the bite of incisors considered, Fig. 31.—Case of Mrs. F—, Fig. 32.—To make a suction upper when the front teeth have to fit over stumps.—Objections to a method of working stated.—Case of Mrs. H—, Fig. 33 . . . 56

CHAPTER V.

PARTIAL VULCANITE UPPERS.

Where a single central alone remains.—Case of the Rev. S. A—.—To get good results when pressing vulcanite between two halves of a flask on a plaster model.—How to tell when enough rubber is packed.—To remove superfluous rubber.—Case of the two upper centrals remaining, Fig. 34.—Mucal base.—Case of the four upper incisors remaining.—Case of Lady F—, Fig. 35.—To refit an upper. To fit the posterior tuberosities.—Case of the six front teeth remaining.—Consideration of the clasps for canines, Fig. 36.—Where a lateral is lost.—Consideration of cases with one or several teeth.—Clasps; their best position, Fig. 37.—Diagonal on which to clip a tooth relatively to drop of plate, Fig. 38.—Stoutness and depth of clasps.—Case of two upper wisdom teeth considered.—Cases of three teeth remaining forming a triangle.—To take an impression of overhanging teeth.—Case where a temporary set is required considered in reference to fees.—Method of refitting piece which has warped in repairing.—Actual size of mucal base no objection to a suction piece, Fig. 39.—To file up and polish vulcanite work . 70

CHAPTER VI.

PIVOTING TEETH.

Method proposed.—To make the tubes and pins.—Instruments used, Fig. 40.—Roots suitable classified.—To excise crowns of natural teeth.—To bore the hole.—To cut the thread of screw.—To fix the tube.—To fit the crown.—To put pin into crown.—To use flatbacks, Fig. 42.—History of 125 cases.—Case of Mdle. S— . . 94

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CHAPTER VII.

GOLD WORK.

PAGE

Comparison of the merits of gold and vulcanite work.—Gold work not to be lightly estimated.—A new invention not necessarily an improvement.—Whether to chase the gold round the necks of incisors or not?—Whether to cut an accurate pattern or not?—To make a lead pattern.—To cut out the gold pattern.—To strike up a gold plate.—Number and function of the zinc and lead casts used in striking up the plate.—The shallow lead.—The striking block.—The hammer.—To get rid of a rock.—Do gold plates warp in soldering?—To avoid straining a plate after it is fitted.—To add the bands to the gold plate 105

CHAPTER VIII.

ON SMALL GOLD UPPERS.

Small vulcanite pieces for single incisors above or below.—Small gold upper for central and lateral.—Miss C—'s case, Fig. 44.—Three methods of making small gold uppers for one or two teeth.—To make a small gold suction piece for one or two front teeth.—Case of Mrs. W—, Fig. 45.—Case of canine and first bicuspid of the same to be supplied.—Of the canine and second bicuspid on the same side.—H-shaped gold pieces for masticating teeth . . . 118

CHAPTER IX.

SUCTION GOLD UPPERS.

Reasons for making a suction gold upper.—Best sort of mouth for suction case.—Classification of edentulous upper jaws.—Semielliptical.—Roman arched.—Semicircular.—Gothic arched.—Flat.—Cases given: Mr. B—'s case, indifferent success, Fig. 48; Miss M—'s case, good, Fig. 49; Miss M—.'s case, good, Fig. 50; the Rev. F. B—'s case, very bad, Fig. 51; Mrs. P—'s case, very good, Fig. 52; Dr. R—'s case, unsuccessful, Fig. 53.—Summary of the conditions of success.—Mr. M—'s case, unsuccessful in gold, successful in vulcanite.—To make a suction gold upper.—Miss S—'s case.—The masticating teeth only on a gold suction upper.—Miss B—'s case (since writing this description of Miss B—'s case she has lost all the natural crowns, flatbacks having been added from time to time, and now wears the entire denture as a suction piece,

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PAGE

It is doubtful if this could have been done in vulcanite.—To relieve the palate if there is a bony protuberance here, Fig. 54.—Miss P—'s case 126

CHAPTER X.

SETS WITH SPRINGS.

Is it better to put springs or not to full sets?—To solder swivels.—Position of swivels.—Curve of springs.—Thrust of springs.—Case of Miss G—.—Case of Mr. W—.—Is it necessary to have two sets?—Strength and length of springs.—To attach springs to set.—Position of swivels 138

CHAPTER XI.

ON MOUNTING TEETH.

Three sorts of teeth used.—Advantages compared.—Advantages of tube-teeth, and objections to flat teeth for the back teeth.—Advantages of vulcanite teeth.—When tube-teeth entirely should be used.—When tube-teeth should be used for the back teeth and flatbacks for the front.—When vulcanite teeth are to be used.—Rate of mounting tube teeth.—Method of doing so rapidly.—Special tools required.—To let down a tooth.—To punch holes for the pins.—To prepare for soldering.—To solder several pins at once.—To fine fit the teeth.—To finish the ends of pins.—The sulphur used for fixing on the teeth.—Consideration of mounting flatbacks.—The backing.—To put up flatbacks.—To solder flatbacks.—To use the blowpipe.—General directions for soldering.—To attach vulcanite teeth to a gold plate.—General directions 147

CHAPTER XII.

ON THE ARRANGEMENT OF ARTIFICIAL TEETH WITH REGARD TO PERSONAL BEAUTY.

To please the patient, his friends, ourselves, and the public.—Difficulties met with.—Tastes differ.—To correct the taste.—The teeth to harmonise with the other features of the patient.—Small bright white teeth.—Observe good looking natural teeth.—To choose teeth.—Remarks on teeth of various makers.—The position, arrangement, and expression of teeth 164

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CHAPTER XIII.

PAGE

ON THE POSSIBILITY OF MAKING PORCELAIN GUM BLOCKS IN THE ORDINARY DENTAL WORKROOM OF GENERAL PRACTICE 174

INDEX 181

ERRATA.

Page 69, lines 19 and 20, *for* "in the December number of the Journal," *read* "at page 53."
„ 152, line 36, *for* "on the line," *read* "opposite the line."
„ 152 „ 37 „ "up the hill," „ "down the hill."
„ 153 „ 1 „ "hole," *read* "hill."

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INTRODUCTION.

Let us try and define what we mean by the word tooth.

It is the fashion to avoid defining, the reason generally given being that there are, on the one hand, so many definitions to choose from that it is difficult to select one; on the other, that there are many things belonging to a subject which it is impossible to bring within the grasp of a reasonable definition. But I think the real reason is that words of general signification are used differently by different people, each being conscious that his idea is not exactly the same as that of others, and cannot therefore be framed by the same definition; still, I think this tendency to avoid definition is unwise. Every one, when using significant words concerning subjects on which he has thought, and about which he is supposed to know something, ought, at any rate, to be able to give the meaning which he attaches to these words, although he may not be able to include in that definition all that every other person means by the same words.

We will begin by considering the word Physiology. This has been defined as the Science of Life, a definition which I do not think will suit us, as it is a conclusion rather than an explanation. It means that life is the result of certain physical arrangements through mechanical and chemical laws. Theology or Metaphysics might each of them be equally well defined as the Science of Life, according to the point of view which the propounder might take of the nature of that

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mysterious principle, or substance, Life. With spiritual or intellectual life, Physiology is not directly concerned, although, of course, in a wider and deeper sense, all the sciences are connected, and grow into or out of each other.

Physiology is a material science, but it is intimately connected with Life.

In the material world we find three great divisions, the Animal, Vegetable, and Mineral Kingdoms. Now, the word is never used in connection with the mineral world, except as this is made use of as food by the other two, or in a metaphorical sense; therefore we must try to find out exactly how it applies in them. These kingdoms are composed entirely of live and dead animals or plants, products of these, or parts of them. Now, it is not the knowledge of these animals or plants in their similarities or differences as individuals which constitutes Physiology—this is Biology; the knowledge of animals being called Zoology, that of vegetables Botany.

Neither is it the knowledge of the parts or products of animals or plants, separately from their relation to, or action in, the living being. We shall not be studying ivory physiologically if we note the shape, size, and hardness of the handle of a dinner knife, or examine its component proximate compounds, as gelatine and calcareous salts, or view its microscopical structure, unless we examine these qualities in reference to their use to the life of the elephant as in their giving strength and consistence to the tusk, which was in consequence able to perform such or such duties in the life and general habits of the animal. It is not only the parts of animals or plants which can be studied physiologically; we may take milk, or tears, or gum, and if we consider them where they are produced and their relation to the life of their producer, they come rightly within our study. And lastly, we may have to consider the foods which nourish these animals or plants.

On summing up we find that Physiology deals with what goes into living things, the different physical parts of them,

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and whatever leaves them, in so far as these substances, parts, or products have reference to their life. We will therefore define Physiology as the *Science of the Physical Machinery of Life; or the Science of the Functions of the Physical Organs of Life.*

The first definition is all, perhaps, that we have legitimately arrived at; the second may be more distinctly and easily recognisable, but it will be necessary to say a few words first of the two words, functions and organs. Life operates and is manifested only through bodies. These bodies are built up into their respective forms, either directly from the mineral kingdom or from the dead bodies of other animals or plants, and one of the principal distinctions between them and mineral substances is that they pass through determinate periods of existence, that is, commencement, life, and death. According to Huxley there is a uniform physical basis of life, to which he has applied the name of "Protoplasm." Without such a material substratum or medium through which to work no one vital phenomenon can be exhibited. This protoplasm can only be chemically described. It consists of the four elements—carbon, hydrogen, nitrogen, and oxygen—united into an approximate compound called protein, which is nearly identical with white of egg. These bodies are not made all at once, but increase gradually or grow; it is therefore evident that a certain *action* must be at work appropriating materials with which to build them up.

The appropriation of food, then, is one of the first *actions* necessary to the existence of life.

Teeth are only found amongst animals, and as, therefore, it will only be with animal physiology that we shall have to do before going any further it may be as well to get rid of plants from our consideration.

To say why this is animal or this vegetable among their lower forms is often very difficult, although there is not now much dispute as to what are animals and what plants; but amongst the higher forms of life one plain and easily

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recognisable distinction is that animals possess powers of voluntary locomotion which plants do not, and as there is a traceable connection, link by link, between the highest and lowest animals, and between the highest and lowest plants, but no relationship or the slightest danger of confusing animals with plants except in their lowest forms, it will be sufficiently distinct for our purpose to call animals *all those living beings which are possessed of the power of voluntary locomotion, together with those which can be evidently classed with them by their affinities.*

As before said, the first function of animal life is to appropriate food in order to grow. In performing the actions necessary to this end some physical force is expended, and as this is obtained by the decomposition of part of the body which is then no longer of the same use that it was before and has to be got rid of, this waste must be made up. The animal has not only to eat to grow but to eat to live, or it would soon waste away to nothing. Thus, there is always waste and repair going on, and it is only when the incomings exceed the outgoings that the animal increases in bulk.

At the commencement of life there is rapid growth, though subject to enormous fluctuations and variations known as metamorphoses; as among insects, where the egg develops into the caterpillar, which grows much in size and changes to a chrysalis, with perhaps loss of substance—this is gradually metamorphosed into a moth or butterfly, which grows but little.

Generally during or up to middle life the increase is slight, after which there is a gradual decrease until death. There is scarcely any standing still, but constant slight fluctuation, with a general tendency to increase or decrease.

The continuance of animal life is provided for by the continual reproduction of young. Certain processes, into which we need not enter, take place, which result in a portion of the animal separating from it, which portion eventually develops into an independent animal. This is

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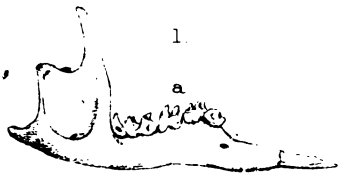

Kangaroo lower jaw.

b

Lower molar, birds eye view to show longitudinal ridge between transverse blades.

c

Upper and lower molars side view to show relative position in chewing.

2

a. *Upper premolar of Leopard in relative position to b, lower molar previous to biting, to show shear-like action.*

3.

Lower molar Hyaena to show basal ridge, compare with hedgehog's at 4.b. and leopard's at 2.b.

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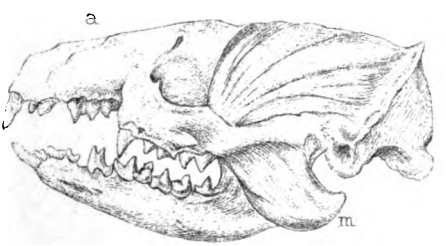

Hedgehog.

b

Lower molar Hedgehog to show protective basal ridge of enamel.

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generally similar to its parent, but not always so, as in some of the lower forms of life it is only the grandchild or great-grandchild which reassumes the original form.

Not only are all *individual* animals descended from previous similar parents, but the different kinds or species can be so arranged, according to their structures and most essential characters, as to form a sort of genealogical tree, suggesting irresistibly the conclusion that they either represent the successive steps of development of idea or invention from one source on which plan they were created, or that the different species have in reality developed one from another. That thus a correct classification really expresses hereditary relationship or consanguinity. The first of these ideas has held sway the longest amongst scientific men, the second is beginning to be fashionable; whether it will be able to maintain its ground seems doubtful, but in the mean time we may bear in mind that, in idea or in fact, not only is there the gradual development of one animal from another, but also the gradual development of one species from another.

The simplest form of animal life, perhaps, presents itself in the form of a little jelly-like mass, composed of the protein of which we have previously spoken. Nevertheless, to quote from Professor Huxley, "it possesses all the essential properties and characters of vitality; it is produced from a body like itself; it is capable of assimilating nourishment, and exerting movements." It has no definite organs or parts; when it moves it pushes out any part of the body which is convenient; when it wishes to assimilate food, it can hardly be said to eat, it places itself over or against the food, which then passes directly into it through any part.

For such animals to be able to maintain their existence the surrounding conditions of life—that is, a supply of food and the absence of a liability to chemical or mechanical injury—must be of the most favorable kind. Consequently we find one of the first things done by animals of this type is to cover their delicate bodies with a tiny calcareous shell.

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These animals, foraminifera, leave holes through their shells in order to protrude their bodies in search of food.

Another very simple form of the same sub-kingdom—that of the Protozoa—presents itself in the gregarinida, animalculæ, commonly found as a parasite in cockroaches; to quote from Huxley, "in the form of a sac composed of a more or less structureless, but not very well-defined membrane, containing a soft semi-fluid substance, in the midst, or at one end, of which lies a delicate vesicle; in the centre of the latter a more solid particle. The enclosed vesicle is probably specially adapted to take part in the process of reproduction, and if so, will at once give us an example of an *organ; it is a part of the body specially prepared to do part and not all of the actions or functions included in the life of the animal.*

An animal is classed higher or lower in the scale of life according to the number and difficulty of the actions which its organs enable it to perform. The animal described is worth remembering, as it forms the model of the ultimate parts by which all the tissues of all animals are developed; suggesting to us an idea as if all the different tissues of the organs of our bodies were built up from the same food by innumerable little gregarinidæ, each doing what it has been in the habit of doing, selecting the required elements out of the food brought to it, and developing therewith the same tissues it has done before, or fresh (gregarinidæ) cells to take its own place; and each that sort of arrangement of tissue suitable to the organ in which it is situated. So that physiological laws, instead of being capable of being analysed into chemical and mechanical principles, as was at one time suspected, can be best expressed as *habits of action,* to which chemical and mechanical laws are importantly subservient.

On the supposition that all complex animals have in reality been evolved from the simpler forms, the suggestion is that each essentially active cell element in their tissues is the hereditary descendant of one of these simple animals,

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and therefore every organ expresses *past habit of action*, as well as facilitates present habit of action.

On the theory of ideal development this would suppose that each of the elementary cells of the body was gifted with a sort of instinct prompting it always to develop in a certain manner; in fact, do that office and no other, which each tissue does.

The real gregarinidæ absorb all their food through the sac-like envelope before described; but in the next sub-kingdom we find that definite organs for the reception of food begin to show themselves. The outside envelope, becoming thicker and stronger, is no longer capable of absorbing all the required food, and a funnel-shaped opening admits it into the interior of the body. This advance in organisation enables the *infusoria* to live where the surface of their bodies is not always bathed in food, as is the case with gregarinida, but then they must search for it, to meet which requirement they are furnished with little vibratile hair-like processes called cilia, by means of which they can swim about. This rise in organisation, you may notice, involves greater difficulty in fulfilling the conditions of existence with a co-ordination of different organs, enabling the animal to fulfil those conditions, a law of general application in the scale of organised beings.

In infusoria we have the simplest form of mouth; an opening to admit food into a part of the body where it will be assimilated.

A little higher in the scale and we meet with animals, fresh-water polyps and sea anemones, having tentacles arranged around the sides of the mouth, the better to convey food into it, and having their insides hollowed into a distinct cavity for its reception.

As a further step, the cavity has another orifice added to it for the escape of such particles as are wanted to be got rid of, an anus; then it is lengthened out and becomes an alimentary canal, part of which becomes enlarged to hold the food when first received, and we have a stomach; an

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organ is developed for sending, or receiving quick messages from distant parts of the body, so as to centralise or more definitely regulate and co-ordinate the actions of all the parts: this is the commencement of the nervous system. The fluid which has been absorbed through the walls of the stomach requires to be distributed to all the organs for their support, and a heart is developed; this is the commencement of the vascular system. This fluid food requires to be yet further decomposed, so that the various parts may choose what they want of it. To do this it is exposed to the action of air in water, by being made to pass through thin tissue, so arranged as to expose a large surface at a time to the influence of these fluids; and we have the earliest form of gills. Soon an organ is added for collecting and expelling effete fluids, the commencement of the urinary organs. Instead of any part of the animal moving when it wants, definite parts called muscles are now specially formed, which only contract when they receive messages to do so sent through the nervous system.

Thus it goes on, organ is added to organ, each enabling the possessor to do something, and thus live in some manner different to any other species, until we arrive at man, whose intelligence is sufficient to allow him to vary his actions and powers by the aid of implements, so that his further development does not seem to proceed so much from the addition to, or alteration of, his bodily organs as from the improvement of his mind and the invention or perfecting of his implements; in both of which respects there is wide scope for Dentists.

Anatomy is the description of the various organs or parts of the body, their forms and relations to other parts.

Comparative anatomy, the comparing these parts with those of other animals; it deals, perhaps, more with the difference of similar organs in different species than with their likenesses.

Comparative physiology, on the other hand, compares the organs in different species in relation to their functions, and

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deals rather more with their similarities than with their differences.

I hope we have now got a pretty clear idea of the scope of comparative anatomy and physiology; it only remains to know what is included in the word *tooth*. In trying to define this word it may be best to begin where there is no doubt that most of our knowledge commences, at the last chapter.

As I have previously remarked, the species of animals can be classified by gradual steps of development and general affinities into a kind of genealogical tree; whether this is by actual hereditary descent, or the process of ideal invention and creation, it follows that organs in their change from one species to another do not suddenly disappear or greatly alter their relative positions; thus, by intervening links we can often trace this sort of genealogical relationship between organs in widely separated species after they have quite lost the same functions. We might easily recognise this relationship in the hind hand of a monkey to the human foot, but we should not so easily see it, perhaps, in the hoof of the forefoot of a horse and our own forefinger.

This is quite a different classification to that of function, and although the general rule is for them to coincide, the exceptions are sufficiently numerous greatly to embarrass definition. As whilst the meaning of words in general language is usually based upon their function or purpose, community of origin has an almost equal hold on our belief as to the kinship of things.

The membrane of a bat's wing has the same function as the feathers of the wing of a bird. The trunk of an elephant may have to some extent the same functions as the human hand, but they are not nearly related genealogically.

The genealogical relations of an organ are called its *homologies*, to distinguish them from its functional relationships, which are called analogies. It is the difference of ranking a man according to his family, or his profession.

In defining a tooth we have to include such organs as the

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teeth in the Echinus, which are hardened by salts of lime; and those of the leech, or on the odontophore of molluscs which are hardened by silica; these are too intimately related analogically to our own teeth to be omitted from the definition, though I doubt if any homological connection can be traced between them; we have to exclude from our definition the beaks of birds, tortoises, and cuttle-fish, the nipping jaws of insects, crustacea, centipedes and spiders, and whalebone of the Right whales.

Teeth were, no doubt, first named from human teeth, and we find their general characteristics to be that they are hard substances of different forms placed just within the mouth, their office being to comminute food before it is swallowed, having no separate motion of their own, but being implanted in a framework by the movement of which they act, and suited by their forms and excessive hardness, to bite, break up, and masticate food, which would be too hard for the tissues that carry them.

Such being their general functions, we will define them as exposed hard bodies placed in the mouth for the purposes of obtaining or preparing food which, without the aid of their hardness, would be unavailable, carried by or implanted in some other softer organ by which they are moved; and also *all such other organs as can be best homologically classed with these.*

The conditions of animal life which are universal, and at the same time most subject to variation and exigence, are shelter from the weather, defence from foes, and a continual supply of food. Wherever we meet with a combination of these conditions, an animal may be expected, which will fulfil in its concrete organization the requirements thereof, to fill the place. These necessities are sometimes partially arranged for in the beast itself; some animals are sheltered by warm coatings of fat or fur, whilst others dig burrows, hide in holes of trees or clefts of rocks, or build warm nests. As a means of defence some bristle with spines, some trust to their speed, some use their horns, whilst others seek their

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burrows, or fly up cliffs inaccessible to their pursuers. Where food varies with the seasons, we find some animals remove their habitations to where they can get the same or similar food, whilst others are so constituted that they can subsist on a change of diet. Of these conditions, the supply of food is pre-eminent; hence, the kind of food made use of has a strong bias in determining the character of the organs of the animal.

Teeth, principally of use in taking and preparing aliment, are likewise often used as instruments of defence and of preparing shelter; they have, therefore, always been of high importance to the comparative anatomist in classifying the brute section of nature.

Cuvier makes principal use of them and the feet, the two most active organs; whilst Owen, on the contrary, though led by these to some extent, gives a higher place to the brain, the most subjective of organs.

The classification of Owen will be followed here, as the affinities of the species seem placed in better order, though I cannot help thinking that the principle upon which it is said to be based is less intelligible than Cuvier's.

Teeth are placed in Mammalia at the entrance of the alimentary canal, between the lips and tongue; they are implanted in the upper and lower jaws, in a manner and with an action with which we are so familiar that they are both difficult and unnecessary to describe.

The details of the maxillary apparatus may be divided into two heads—firstly, the forms of the teeth; and secondly, the arrangement by which they are used. The former may be arranged roughly into cutting, piercing, and chewing; the latter into bones to carry, and muscles to give force to the former.

The muscles may be divided into those for opening the jaws, and those for biting, crushing, and grinding.

In the skull of a fossil tortoise (the dicynodon), we find the three forms of teeth in their simplest conditions.

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The temporal muscle is the biting muscle, reaching from the upper back part of the skull through the zygomatic arch. It is inserted into the coronoid process of the lower jaw, so near to the hinge of the joint that it makes of the lower jaw a feeble lever of the third power, being far too weak to do much work in crushing or masticating the food; but what it loses in power it makes up for by the quickness with which it can throw the front teeth through a large space, giving to all predatorial animals that sudden snap by which they seize an agile living prey. Hence we find it largely developed in all such beasts—badgers, hyænas, cats, bears, wolves, seals, hedgehogs (Pl. I, fig. 4), bats, some monkeys, &c.; whereas in the herbivores—sheep, horses, &c.—it is exceedingly small.

In some Rodents, however, as the guinea-pig, it is tolerably developed, and, from a peculiar form of the coronoid process, is of use in drawing the jaw backwards rather than upwards.

In chewing, the crushing power exerted only for a short comparative distance requires greater force; hence we find the masseter and internal pterygoid muscles, which are more advantageously placed to render it, large in herbivorous animals, but particularly so where the food is very hard, as in the horse, beaver, &c.

Wherever there is required a slow but powerful upward thrust of the lower incisors, as in pigs (rooting), many Rodents (gnawing, &c.), these muscles, or at any rate the masseter, have their efficiency increased for this purpose by having the posterior angle of the jaw largely developed backwards (see hedgehog, Plate I, fig. 4, *m*).

Cementum, dentine, and enamel are found in most teeth, but in some the enamel is wanting, as in the tusks of the elephant; in others the cementum is absent, as in the incisors of rodents; but dentine is common to all.

The office of dentine is to give strength to the tooth. The enamel forms a protective cap to the tooth, sustaining wear much better than the dentine, though too brittle to form the

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body; also it often serves to keep a certain form constant, by arrangements in which the dentine and cementum surrounding it, being softer, are constantly worn away to a lower level.

The cementum, more highly organized than either of the foregoing, seems to form a connective tissue with the vascular system. At other times it takes its place as a yet softer substance than dentine, in maintaining an efficient form to the tooth.

In Mammalia the lower jaw alone moves; and it has been observed by Owen that the condyle is always convex, whereas in cold-blooded reptiles and hot-blooded birds the articulating surface of the lower jaw is concave, receiving a projection from the skull, on which it moves. To account for this fact I will hazard the following conjecture.

In Mammals there is always some variety of motion required from the jaws in preparing food; being warm-blooded, the quick consumption of their system requires it; hence the condyle must have some scope of action. In such a case it is best economy for the most movable of the contiguous surfaces to play within the other, in the same way that a pestle moves in a mortar—the power is applied to the convex part, the pestle, not the mortar.

In neither birds nor reptiles does this chewing take place. In birds, that the head may be light and not overbalance them in flight, the masticating apparatus, the gizzard, is removed into the body.

Reptiles, being cold-blooded, probably do not require to masticate their food, but swallow it as nearly whole as possible. Thus there is no variety of movement—the jaws simply open and shut; added to which (in all the specimens I have been able to observe), the lower jaw is more massive than that part of the skull with which it articulates.

At the bottom of our classification stands the Echidna, a spiny ant-eater, which possesses no teeth, but has the deficiency supplied by immense claws, which serve him at the same time to obtain access to his food and to escape from his foes. The

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latter he can do so effectually (according to Waterhouse) that one disturbed by some travellers in Van Diemen's Land sunk itself perpendicularly into the earth, keeping its spiny back only accessible to the intruders. In consequence of this faculty it has not the power of rolling itself into so complete a ball as our common hedgehog, which, not possessing much, if any, burrowing powers, requires this means of making a similar coat defensive.

The ornithorynchus has weak, horny molars, and no front teeth; but, in compensation, the most perfectly webbed feet of any Mammal, enabling it to pursue its food—aquatic insects and mudworms; it has likewise powerful burrowing claws, which it is able to use by folding back the web, which, whilst swimming, completely blinds them.

We may notice that wherever the front teeth above and below are wanting, an extraordinary development of claws supplies their place.

The genera marked by this omission were united in one order by Cuvier—that of Edentata; and the affinity seems very close, for all the other genera—sloths, armadillos, and different ant-eaters—have immense claws.

In the sloths these claws serve to suspend the animal from the lower sides of branches, whilst it feeds on their leaves secure from enemies. One species, indeed, possesses canines, but it only has two claws on each limb, whilst its less fortunate relatives possess three.

The armadillos, besides burrowing, are defended by a scaly coat of mail. Their grinding teeth are of a very simple description, and they seem to live on insects, decomposing carcases, and vegetables. So formidable are their burrowing powers that (according to D'Azara) inhabitants of the parts frequented by them are obliged to protect their dead by driving boards deep into the ground round their graveyards.

The true ant-eaters possess no teeth, nor can I learn that they burrow; their enormous claws seem sufficient protection. Their mode of defence is to await the adversary sitting

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up, seize him in their fore-paws, and press their claws into him. In 'The Naturalist of the Amazons' the author gives a graphic engraving of one of these animals punishing a dog of his own in this manner.

Of the Marsupial Carnivora, Dasyures and Thylacines, there does not seem much to notice which we shall not find more typically developed among the Placentals. Not having the speed of the dog, or the retractile claws of the cat, they content themselves with less active or feebler prey; and the molars possess an inner cusp, which is probably of use in holding in place the cylindrical bones of small animals whilst they are crushed by the opposing tooth, as these isolated talons are found less and less numerous in flesh-eating animals, in direct ratio with the comparative size of the prey to the animal, until we find in the feline species there is only one in the large upper premolar.

Of the phalangers and opossums I cannot find much information, nor do they present very manifest characteristics.

Occupying a similar position amongst Marsupials to that taken by Ruminants in the Placentals, are kangaroos. They possess, however, very different teeth. Having upper as well as lower front teeth, the latter being found in the higher form of animals alone, they are enabled to crop harder and dryer herbage, and their molars are superlatively formed for clipping into short lengths such food as dry grass or hay; they are composed of a series of transverse short blades (Plate I, fig. 1, *a*), in which the lower close just behind the upper like the blades of a pair of scissors (Plate I, fig. 1, *c*), with the exception that the edges close parallel to each other instead of at an angle. That the food should be seized and cut when the jaw moves from side to side, instead of falling away on either side, it is necessary that the blades should be a little hollowed on their edge; to accomplish this, a slight longitudinal ridge rises between the blades, which is just reached by the edge of the opposer when the mouth is shut (Plate I, fig. 1, *b*); this wears the middle part to a

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lower level than the corners, and keeps the required form. The blades, wearing against each other, keep themselves sharp: altogether it is a very efficient chaff-cutter.

The front paws of the kangaroo are so short that its head is nearly horizontal when grazing, in relation to which position the lower incisors are horizontally placed, and the upper perpendicularly, so that the grass rising into its mouth is divided by these teeth at an equal angle, the lower being probably thrust forward by the pterygoid muscles, instead of being shut in the ordinary manner; for, in addition to the relative inclination of the lower incisors, there is a peculiar hollowing of the inside back part of the lower jaw, corresponding to the position of these muscles; but, not having succeeded in getting a fresh head for dissection, I am unable to describe it.

Burrowing animals are very liable to meet with roots in their way, and those who are not possessed of powerful claws to enable them to force it, as the armadillos or moles, are provided with sharp teeth to gnaw a passage; these would be liable to great wear, and we have the endless chisel-shaped incisors of the Rodents. They form part of a circle of prismatic section, the anterior surface strongly guarded by enamel. The end, which is implanted in the jaw, is open, and filled by the formative pulp, as in all continuous-growing teeth, which supplies the continual wear. The dentine, from its softer consistence, wearing to a lower level than the enamel in front, maintains the tooth sharp. To bring this construction to its highest efficiency it is necessary that there should be no lateral motion, which would throw the edges of the front teeth across each other, and destroy that evenness of wear essential to sharpness. In the wombat, a burrowing Marsupial Rodent, this is not provided for; the front teeth are so placed that they wear themselves flat upon each other, and a sharp edge is obtained by allowing the teeth to follow the curve of a large instead of a small circle—a manifest disadvantage.

Amongst the true Rodents this is not the case, and they

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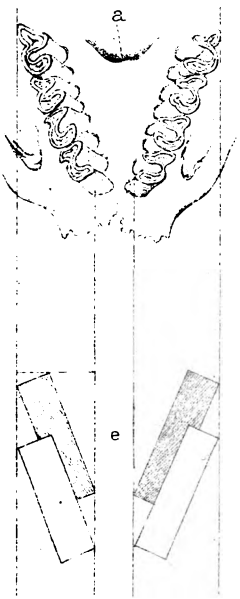
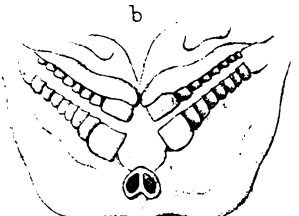
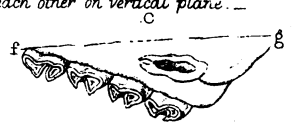


a, Guinea pig's upper molars viewed from below to show inclination of the general line of teeth on each side to the other on horizontal plane

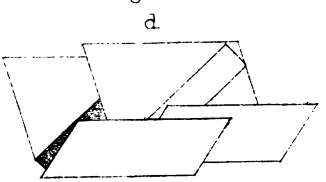
e, Rectangles representing the relative positions of upper & lower teeth, when the lower are moved forward, showing how much of the upper (shaded) would be then uncovered. —



Front view of Guinea pig's molars, the incisors being removed, shewing inclination of surfaces to each other on vertical plane. —



Side view of Guinea pig's upper molars to shew inclination of general line of grinding surfaces to line of motion f. g —



d, Rectangles representing upper & lower molars as at e placed diagonally on the sides of two troughs, which can slide horizontal one within the other, being the real relative position of the grinding surfaces of teeth, in the Guinea pig. —

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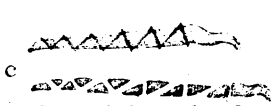
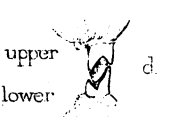
a. Upper jaw of mole. b, lower jaw



c, Worm shewing the line and number of pieces in which it would be cut by a bite from mole

d, Section of worm in position between teeth before being bitten. —



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file up their food by a backward and forward motion, to which end we find the condyle of the lower jaw laterally compressed, and working in a longitudinal furrow in the skull.

Many of the patterns of molar teeth in Rodents are very beautiful, their form being mostly maintained by various dispositions of dentine and enamel. The softer dentine, continually wearing to a lower level, always keeps them sharp.

The common guinea-pig presents some interesting features of this order. In gnawing, a large swift bite is not required, but a slow, powerful one; so we find the coronoid process of the lower jaw but rudimentary, and the temporal muscle elongated and attached to the bone, anterior to the usual position, so as to enable it to draw the jaw backwards; the posterior angle of the jaw, on the contrary, is lengthened backwards into a considerable process, so as to give greater scope to the masseter and internal pterygoid muscles in throwing it forward, which is yet further enhanced in the masseter by part of this muscle being produced through the bone to the front of the face, and thus a forward and backward motion is obtained.

Amongst those animals whose condyles do not permit of much lateral motion, the leverage of any such force upon the front of the mouth would throw too great a strain upon them. This is guarded against in the Carnivora by the lower canines being set so as to lock in front of the upper; but, the little animal under consideration not having any canines, the molars are so arranged that the faces of the lower ones slope inwards at an angle of about 45 degrees, whilst those of the upper slope outwards to correspond (see Plate II, fig. 1, *b*).

Those animals, on the other hand, which grind their food by lateral motion, are enabled by this motion to bring the surfaces of the teeth out of opposition, so that they can receive and carry back, into a position where it can be crushed, food from the cavity of the mouth.

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In the guinea-pig, to meet this requirement, the teeth are approximated at an acute angle anteriorly, so that in the mere backward and forward motion before mentioned the surfaces are brought from opposition (Plate II, fig. 1, *a*, *e*). But that the surfaces should incline to the vertical plane, whilst the lines of the teeth inclined on the horizontal plane, and, at the same time, that there should be a free horizontal motion, requires yet another modification; for on this simple construction it is evidently impossible.

Let us suppose two troughs, each composed of two rectangular planes, meeting in the same angle on their longest sides. These troughs would fit each other, and would slide freely backwards and forwards. Now, we will make a band on each side of one of these troughs, straight from the angle at the bottom of the trough in front, up to the corner at the edge of the trough above behind, and similar bands on the other, so that the bands on the one trough exactly superpose those on the other. We shall thus have two converging bands on each surface, which incline towards each other when seen either in front or from above, and which are at the same time capable of a forward and backward motion in the horizontal direction. Now, if we outline upon these bands the shape of the guinea-pig's upper and lower molars respectively, we shall have their precise relative position, thus accounting for the fact that the tops of the molars are much lower, relative to the line of their horizontal motion, in front than behind (see Plate II, fig. 1, *c*, *d*).

The hedgehog is a familiar example of Insectivora: possessed of only rudimentary canines, and, not having either teeth or claws suitable for burrowing, he is defended from his foes by his prickly coat, into which he has the power of contracting himself. With projecting lower incisors for grubbing up stones, &c., in pursuit of insects, he, in like manner with the guinea-pig, has the angle of the lower jaw produced backwards, to enhance the power of the masseter muscle to give a forward and upward thrust (Plate I, fig. 4, *m*). Insects having systems supported generally by an

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external framework, and being often cylindrical in shape, the teeth of Insectivora bristle with sharp cusps, which at the same time keep the prey from slipping away, and crush in its covering. Some insects, beetles, &c., upon which the hedgehog feeds, possess horny coverings, sharp claws, &c., to prevent which wounding the gums the teeth are surrounded by a protective guard of enamel, which stands out round the base of the crowns (Plate I, fig. 4, *b*).

We meet with a similar provision in the hyæna. This animal, not possessing the sharp retractile claws of the cat tribe, nor the elongated muzzle and speed of the dog, is at a disadvantage, and is often driven to feed on the leavings of these species, to avail himself of which he is possessed of muscles capable of cracking bones which have been left, and its teeth, similar to cats' in other respects, are analogous to those of the hedgehog in possessing the protective basal ridge of enamel, which in this case serves to ward off splinters of bone (Plate I, fig. 3).

To return to the Insectivora. The mole does not possess the gnawing front teeth of the Rodent, as it requires teeth by which it can seize and drag out worms—its principal prey—as they quickly shrink into their holes; it is furnished, in compensation, with immensely powerful fore-paws, by which to force its way past obstructions, as is familiar to most of us; but it is the arrangement of the molars which are especially interesting from a mechanical point of view. Animal food does not seem to require much crushing, but rather comminution; and the molar teeth of the mole are so formed as to mince up their food into numerous triangular morsels at each bite. This is effected in the following manner:

Imagine two cutting edges, one above and one below, on each side of the mouth, so arranged as to pass each other and cut like the blades of a pair of scissors; it is evident that these would only make one division of the worm at a time on each side, and if it fell on the lower blade longitudinally (the most convenient position) it would probably be allowed to fall on one side, or at most would be only split in two; if,

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now, we zigzag these blades, keeping the same reciprocal cutting relation between the upper and the lower, whilst there will be width of edge for the worm to lie upon, it will also be cut into as many pieces as there are angles in the zigzag; that is, supposing the worm not to be wider than the mean width of the tooth. But there would still be a tendency to slip on one side, therefore a longitudinal notch is cut the whole length of the zigzag, both above and below. An end view of the row of teeth, with the worm in position, would give the appearance of a circle embraced between two angular forks (see Plate II, fig. 2, *d*).

This curious pair of zigzag scissors is constructed in the following manner:—Each of the three molars in the upper and lower row is composed of two triangular prisms, placed so that their bases form a continuous line, the angle standing outside in the lower jaw, and inside in the upper; and so arranged that the angles of the one fit exactly between the angles of the other (see Plate II, fig. 2, *a*, *b*). As these prisms are solid, to give the edge spoken of above, a notch is cut out of each base, the angle of which slants up to the angle of the prism, and both the other sides are notched by the longitudinal cut before spoken of. As there are three molars, a thin worm, such as the wireworm, would thus be cut up into twelve little pieces at each bite, or there would be six pieces taken out of the side of a larger one (see Plate II, fig. 2, *c*).

The lowest genera in the next subclass, that with convoluted brains, is that of the whalebone whales, which, however, possess no true teeth, their want being compensated to the animal by the whalebone filter, which has been repeatedly described.

Among the toothed whales which follow, the narwhal has an extraordinary development of one of the teeth homologous to the central incisor. This is prolonged to the front of the mouth, nearly in a line with the long axis of its body, to the extent of six or eight feet; it is straight, and of the form of a gradually tapering, slender cone. This species inhabits the

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bays in the Arctic Circle, where, in the winter, ice is often rapidly formed on the surface; and it is supposed that the function of this spear-like tooth is to pierce an air-hole through the ice, in case of emergency.

This suggestion is strengthened by the following analogy. The walrus, living in the same neighbourhood, is provided with two large tusks, projecting downwards from the front of the mouth, to assist it in raising its massive body on to the ice. These teeth, which are canines, he dashes into the ice, as far forwards as he can reach, and then, by means of powerful neck muscles, draws himself up to repeat the process. Dentine, as we all very well know, has a tendency to split down the long axis of the tooth, like wood; and the violent concussions to which the walrus subjects his canines would be likely to split them, if solid, of the ordinary tooth substance; but when the tooth is about half formed in thickness, from the outside inwards, the formative pulp changes the character of the calcified mass, and the dentine forms in nodules, a little like granite in structure, though maintaining the same density and firmness as before. This unsplitable central column succours the outside layer of dentine, though to the latter the tooth owes its longitudinal strength and immunity from transverse fracture. The narwhal's tusk, it is true, has not this central granular column, but it has a feature which, as it would accomplish the same end, indicates a similar function: it is spiral in itself, that is, twisted like a rope, not like a corkscrew, and thus any tendency to split is avoided, as transmitted force would be divided, and, proceeding in opposite directions, would nullify itself. This spiral growth also ensures the straight development of the tooth; any irregularity, being soon transferred to the opposite side, corrects itself. The same method of preserving unsplitability could not be used in the case of the walrus, whose tusks being employed as hooks, require a slight curve.

Some doubt (based on the microscopic structure) has been expressed by Mr. Spence Bate, as to whether the tusk of the narwhal does really turn as it grows; and as it is not very

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easy to put the question to the test by catching a young narwhal and marking the tusk at different stages of growth, I shall give the following theoretical reasons for believing that such is the case.

In the first place, it is perfectly straight and projects almost horizontally from the snout of the animal. Now, from what we know of the effects of gradual steady pressure on the shape of growing teeth, we may believe that, if it merely grew straightforward, the force alone of gravity would give it a downward bend, for the weight of the tooth is very considerable long before it has attained its full development.

In the second place, the dentinal pulp only grows forward from the base; there is no interstitial growth of the dentine, so that there would be no motion during formation between the pulp and this tissue; therefore, although the fibres might arrange themselves in spiral succession, there would be no microscopical evidence of it; they would still run in straight lines in the radii of the transverse section, just as we see bristles in the common spirally-twisted bottle-brush. On the other hand, as it is externally marked with a spiral twist, if this grew straightforward from the basal pulp, it is evident that the external form of this must keep constantly revolving, whilst its substance, in this relation, remained motionless. This alternative appears to me much more improbable than the other. The opinion that the tooth does revolve in growth is yet further strengthened by reference to the formation of the cementum. The capsule which forms this substance does not follow the growth of the tooth like the dentinal pulp, but remains in a band round the outside of the base, laying the cementum on the dentine as it passes, and therefore the layer close to the dentine will be laid when that part is on the internal edge of the formative band, whilst the last layer will come from the external edge; and we might expect to find some traces of this lateral motion left in a vertical section, just such indeed as we do find. Taking all these indications into consideration, I

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cannot but believe that the narwhal's tooth does revolve during its growth.

There is another mechanical advantage in the construction of this tooth pointed out by Owen. In order to lighten it somewhat the pulp remains uncalcified, to the amount of about one third of its thickness, throughout the front part of the tooth, but narrows in, so as to leave that part implanted in the socket nearly solid.

Passing over the manatee and dugong, of which little seems to be known, we next, among recent Mammals, arrive at the elephant. This animal presents us with some features in its dentition analogous to that of Rodents: its tusks, like their front teeth, have persistent formative pulp, and continue to grow during the life of the animal.

It may be a question whether a change of climate did not deprive the Northern Circles of woods before it exterminated the members of this genus within its confines, as the great tusks of the Northern mammoth are often recurved to a considerable extent, just as we might imagine those of the elephant would grow if deprived of the wear and tear of use. If this be a correct guess, it would be a rather curious illustration of how far adaptation to change of circumstances takes place, as there is good evidence that the mammoth of Siberia, in its latest stage of existence, was abundantly covered with hair. In this case the cold, which had rendered its tusks useless, had failed to remove them when only an incumbrance, but had, at the same time, stimulated the adaptive faculties of the animal into greatly increasing the warmth of its covering by a warm coating of hair.

The molars of elephants still strengthen the idea of relation to Rodents, being very similar to those of the capybara, the largest existing representative of this order. They are composed of a number of transverse layers of dentine, enamel, and cementum, which, by their irregular attrition, give the top of the tooth always the surface of a very rough file. There is a difference in the disposition of these tissues in the African and Indian elephants.

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The enamel of the African elephant is arranged so as to enclose diamond-shaped spaces of a softer tissue; the diamonds are placed, touching each other by their obtuse angles, all along the centre of the top, the length of the diamond corresponding to the width of the tooth. In the Asiatic species, the surface of the grinder presents a nearly parallel series of transverse lines of enamel, the comparative result of the two methods being that the African tooth is a much coarser rasp than the Asiatic. The female of the former species has nearly as large tusks as the male, whilst in Asia she is either totally devoid of them, or they are exceedingly small. Now, the principal use of the tusks is to prise up trees in order to browse on the branches; hence it would appear that the female of the Asiatic elephant, being unable to provide herself with such large branches as the African from her want of tusks, does not require so rough a molar for their mastication, and for this reason the teeth have been modified in the whole species.

Among the odd-toed Mammals, the rhinoceros, an almost exclusive grass eater, is very poorly furnished, for his size, with front tusks, in comparison with his rivals in bulk, the elephant and hippopotamus, having only insignificant incisors, to compensate for which deficiency he carries on his nose a powerful horn, to use either as a weapon, or for forcing his way through impediments in the undergrowth of the thick forests he inhabits.

The solid-hoofed genera—horse, ass, zebra, &c.—seem to be the type of speed among herbivorous quadrupeds, and their superiority in this respect over the Ruminants (which, embracing the antelopes, deer, &c., possess many very swift species) seems to turn on the fact of their having upper front teeth as well as lower. In consequence of this they are enabled to take harder and more nourishing food, such as ripe corn, beans, &c., to the grinding of which their molars are specially adapted. This more concentrated food furnishes them, in smaller bulk, with that force which is the reservoir of their speed. Being thus able, at any time, to

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set a pursuer at defiance, they do not require to eat their food in haste and retire to obscure retreats for protection. Their hoofs are therefore formed for rapid progression on the unvaried plains where they browse. Here, in the midst of their sustenance, they can afford time to chew it properly as it is eaten, and therefore have no need for chewing the cud afterwards.

In the various accounts of foreign field sports, such as Gordon Cumming, &c., one reads of all the antelopes, deer, buffalos, &c., being run into by the mounted hunter, but of zebras or quaggas never; whilst it is reported that the Arabs, in order to capture the wild ass, are obliged to place relays of fresh horses along the route of its expected flight.

True, Ruminants embrace many widely spread and numerous species. Vast herds of antelopes in Africa, which, browsing on the open plains, retreat to the hills, woods, or marshes, to chew the cud, living less amongst woods than the deer tribe, are furnished with superior weapons of defence, in the shape of long, sharp, powerful horns, without prongs, which they use with such effect that Gordon Cumming relates of a wounded oryx held at bay by his dogs, that, ere he could come up, four powerful hounds were placed *hors. de combat,* the antelope stabbing right and left but twice.

Closely allied to this genus are the deer, which, being more sheltered in woods, their usual habitat, do not require, perhaps, so deadly a weapon of defence, but combine with it a means, in the shape of diverging prongs, of quickly lifting up, in order to pass under, any obstruction of branches, &c. Sheep and goats select mountains for their fastnesses, and their horns are generally so turned at the end as to protect the head, and receive the brunt of falls over rocks, &c.

Oxen depend upon their powerful horns, and the mutual protection of association, for defence; and often seek a succulent pasture, combined with shelter, amongst the reeds of marshes and river banks.

As I have before stated, this family have no front teeth;

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and only a few—the camels, llamas, and musk-deer—possess canines. It is worth remarking that these are not supplied with horns. Possessing no front teeth, they cannot take such concentrated food as the horse tribe, and are, therefore, not so capable of saving themselves by flight, partly because, from the nature of their food, they require a greater quantity, which interferes, to some extent, with the compactness of their build; and partly, probably, from the inferior force-producing nature of that food. They are, therefore, provided in their economy with an arrangement by which they are enabled to crop quickly a large quantity of food, without chewing it at the time, and then, retiring to safe quarters, submit it to mastication at leisure. In doing this, they will have to travel over more varied and unstable foothold than the plain-keeping horses; and, in order the better to do so, their hoofs are cloven, which gives them greater holding power. In the before-mentioned books of field sports it is common to meet with instances where the hunter, on horseback, lost his game by its taking to hilly ground, where his horse, which had been previously gaining upon it, was entirely thrown out.

The entangled mass of grass which Ruminants have to chew requires to be cut and crushed in every direction, and the means adopted for this is very perfect and complicated. The molars are arranged in a series of semilunar plates of dentine and enamel, the convexity in the upper being inwards, in the under outwards, so that in chewing the action is reciprocal. The tops of the teeth present two platforms, at different levels, which reciprocate between the upper and lower jaws when they meet; that is, the innermost platform of the upper tooth falls upon the outermost platform of the lower; whilst the outermost of the upper and the innermost of the lower fall free of any opposition (see Plate III, fig. 3). The walls, which form the step from the higher to the lower level, in the upper and lower teeth respectively, pass each other with a scissors-like action, by which a mass of food is first divided and then enclosed between them, until the lower-level plat-

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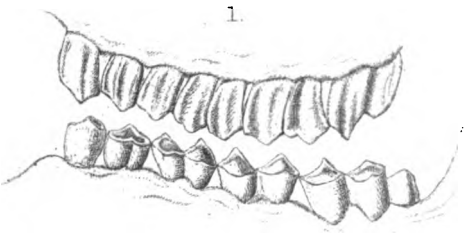
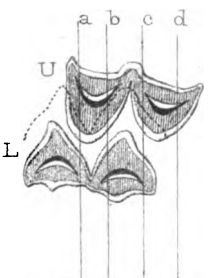
1.



1 *Side view of molars of Sheep, to show zig zag line of wear.*

2.



2 *Grinding surfaces of molars in their relative lateral position, shewing that all the tooth substance between the lines a, b in the upper would wear against the small quantity between a, b. in the lower whilst the large mass between b c in the lower would wear against the small mass between b c in the upper thus producing the zig zag wear of Fig. 1. The dotted line represents the actual position of the lower on the upper and shews how the Fig. 4 is obtained.*

3.

3 *Section of upper and lower molars of sheep to show their relative position just previous to biting food, also how the disposition of enamel keeps one platform higher than the other.*

4

4 *Shews the zig zag row of lanceolate shapes which would represent the crushed grass, punched out by the sheep at each bite, on each side.*

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forms meet and crush it. I am afraid this description is not very clear; but any one who will take a sheep's skull in his hand will readily understand it.

The maintenance of this form to the tooth is regulated by the shape of the teeth and the disposition of the dentine and enamel. For example: in the transverse vertical section of the upper molar of a sheep, first comes a strong layer of enamel, then a thicker one of dentine, another of enamel, then a deep slit, dividing the wall of the external platform from the internal one; next, a very slight film of enamel, another layer of dentine, and, lastly, an outside of enamel again. The consequence of this disposition is that the dentine, which is protected next the indentation by only a rudimentary film of enamel, wears to a much lower level than the other, and the required step is produced on this side of the lower platform, whilst the enamel on its other side, which would otherwise keep it high there, is worn down by being opposed to a much greater body of enamel in the tooth which meets it; that is to say, the broad platform, which is the higher one in each tooth, wearing the convex platform, which is the lower one (Plate III, figs. 2 and 3). But, if these platforms were mere plain longitudinal steps, it is clear that the enclosed food, finding no escape, would offer too great resistance to be crushed. But, by disposing them in a series of angles, only part will meet at a time, which will facilitate the action. To produce this form, the teeth are so placed that the middle of the solid part of the teeth in one jaw falls exactly between the semilunar convexities in the other (Plate III, fig. 2), where it, of course, meets with less tooth substance to wear; the reciprocal effect of which is that a side view of the teeth presents the appearance of two zigzag lines, the angles of the one corresponding to the depressions of the other (Plate III, fig. 1). By this arrangement, also, so much of the flat surfaces do not meet each other; the semilunar margins, alternating when they meet, cut out and crush a series of zigzag, lanceolate forms, thus dividing the blades of grass in every direction, however they may lie (Plate III, fig. 4).

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The even-hoofed Mammals, which do not chew the cud, are yet slower again than the Ruminants, but are generally fiercer in disposition, having large developments of their canines, which, like the incisors of Rodents, are always growing.

The hippopotamus inhabits rivers, and feeds much on the roots of aquatic plants, and is well provided, in the incisors and canines, with picks to root them up and shears to clip off the more stubborn.

The hog tribe are also probably root-eaters principally, having protruding lower incisors with which to grub them up. They defend themselves vigorously with their long powerful canine tusks.

The fin-going animals, the seals, live on fish, and their molars mostly present a series of tridents, with which they can hold firm their slippery prey when seized, whilst they have well-developed canines as a means of defence.

Toe-walkers comprehend the most agile of the Carnivora. Of these, the cats, possessing retractile claws, are unable to run down their prey, but spring upon it from a place of concealment; these sharp claws enable them to hold it whilst they destroy life with their formidable canines. They are among the largest of the genus; and the lion and tiger, by their weight, are able to drag down such large game as buffaloes and the larger antelopes and deer. The mane of the lion is a valuable protection from the rude shocks which would be met with if he sprang upon one of these animals in a rocky place, and both rolled over together. With small incisors for scraping the bones, they have large trenchant canines, the lower passing in front of and within the upper, thereby preventing any danger of dislocation to the jaw in the struggles of the prey. This disposition of the canines is all but universal, and, I believe, with the same object, viz. to secure the lower jaw from closing out of its place, and so getting the cusps of the teeth entangled, or straining the articulation of the jaw.

The molars in the fore part of the mouth in cats are

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mostly composed of one strong laterally-compressed cone, guarded before and behind by a small tubercle, which protects the gum; their function seems to be to assist the canines in holding the captive, and to joint the larger bones. Behind these, above and below, comes a single large tooth on each side, which is so indicative of the flesh eater that Cuvier named it the carnassial tooth. They have two strong cutting edges, which meet and pass each other like the blades of a pair of shears. If the edge were straight, as observed with regard to the kangaroo, there would be a tendency in any unyielding substance to slide forward, therefore the edge forms a waved notch, so that on closing the jaw it encloses the substance first, and then cuts it (Plate I, fig. 2). In order to preserve this form, as the teeth wear away, they slope at an acute angle from the side which rubs against the opposer, which latter side is perpendicular.

Dogs, having no retractile claws to help in seizing and holding their prey, have their muzzles elongated, which gives room behind for more molars, one of which is tubercular and possesses a large masticating surface; whether this has any relation to their endurance in running or not, I can only surmise.

Cuvier speaks of the carnassial teeth of cats as particularly adapted for cutting up flesh, but I imagine that they tear off as large pieces of flesh as can be swallowed, which receives no further chewing; and that the essential function of these teeth is rather to divide the tough tendons which attach the muscles to the bones.

Amongst the lemurs, the galeopithecus, or flying lemur of the Indian islands, presents a unique dentition. It is destitute of upper front teeth, whilst those in the lower jaw are deeply indented, like the teeth of a comb; and as its back teeth are of a well-marked insectivorous type, it is possible that their function consists in searching the backs of other animals for parasites or larvæ.

The teeth of monkeys are generally frugivorous in their character, but they vary so much, and authentic records of

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the modes of life of their possessors are so sparse that I shall not attempt any analysis of their action.

Having taken a cursory view of the more marked mechanical conditions of the masticating apparatus and functions in the lower animals, let us turn to those of man.

In the first place, it will, perhaps, be best to enumerate those conditions of the natural organs which are most constant; then attempt an analysis of their actions and functions; and, lastly, make suggestions for the practical fulfilment of these conditions in our operating and work rooms.

It is a fact familiar to every Dentist that the lower teeth bite inside the upper all the way round, so that a line passing through the external points of the under back teeth falls about midway between lines passing respectively through the external and internal points of the upper back teeth, and that the edges of the lower front teeth fall well inside those of the upper; nevertheless, the lower canines shut *in front* of the upper, having less space between them for the incisors; consequently, we find the lower incisors less than the upper.

In speaking of the relative sizes of teeth throughout this paper, it will be well to remember that only the masticating surfaces are referred to.

The lower centrals are smaller than the laterals; the upper centrals are larger than the laterals.

The lower canine, at its neck, projects more to the outside of the mouth; the upper, more to the inside.

The lower first bicuspid is either equal to, or smaller than, the second, measuring on the outside in the general line of the teeth; seldom, if ever, larger.

The upper first bicuspid is almost always larger than the second in the same direction.

The upper bicuspids are composed of two cones or pyramids connected at the sides by transverse processes.

The lower first bicuspid has but a small inner cusp, with its anterior transverse process rudimentary.

The lower second bicuspid is almost tricuspid, the

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cusps much blunter than in the other teeth of this type, and with the transverse processes almost form a circular ridge.

The lower first molar, measuring in the general line of the teeth, is a little longer than the upper, often has five cusps, nearly rectangular in shape, and set with its shortest diameter at right angles to the general line of the teeth.

The upper first molar is a rhomboid in shape, the acute angle being the external anterior one, and the line of the two exterior angles parallel to the general line of the teeth. It possesses four cusps; the front internal one sends a ridge of enamel back to the posterior side of the external back cusp.

The second and third molars seem to be repetitions of the first molars, upper and under respectively, not quite so well defined, and with their cusps gradually lowering as they go back, with this exception, that the farther back in the upper jaw the higher become the internal cusps comparatively to the external; in the lower, the higher are the external relatively to the internal.

Transverse sections show that in the lower molars the outer cusps are blunter than the inner; in the upper the outer are sharper than the inner.

In both molars and bicuspids there are running down from near the points of the cusps, enclosing leaf-shaped spaces, sundry grooves, which meet in larger ones lying at the bottom of the depressions between the cusps.

From the canines to the wisdom teeth, on the inside, the distances between the tops of the cusps are either equal, or decrease as they go back; they never increase; on the outside they always decrease.

Looking from above, the articulating posterior outline of the condyle of the lower jaw appears formed of parts of two circles. The inner and larger forming part of the same circle as the symmetrical part the other side: the outer small curve forming part of an independent small circle.

A side view shows that the condyle articulates with the

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glenoid cavity, so as to allow of a simple hinge-like motion, and a forward and backward motion.

Placed immediately in front of it, just under the commencement of the zygomatic arch, is a ridge which has the effect of depressing the back part of the jaw in its forward motion.

In trying to analyze the relative actions of these parts I was, at first, a good deal puzzled by the consideration that possibly structural, anatomical, or rudimentary adaptations might interfere with the merely mechanical construction; but some of the facts of comparative anatomy seemed to give assurance that little would be found useless.

If we compare the central teeth of the narwhal, or the laterals of the elephant, with those of rodents or the carnivora; the canines of the wild boar or walrus with those of man or the horse; the premolars of the feline species with those of the ox tribe; and the molars of the elephant with those of the seal; I think we shall be forced to admit that mechanical adaptation to its purpose triumphs over typical forms, or the difficulties of organic construction.

It is unnecessary for the practical Dentist to inquire into the causes of several features in the human dental system.

We may assume the number of teeth to be thirty-two, equally divided between the jaws, and arranged in two uninterrupted nearly parabolic curves, lying between the external margin of the tongue, and the lips and cheeks.

The lower jaw is possessed of a combination of both horizontal and vertical motion, which it will be convenient to consider separately.

When the teeth are shut, the condyle lies at the back of the glenoid cavity, where, the front of the lower jaw being depressed, it turns like a hinge.

Looking at the jaw from the side, the teeth present a series of cones which so nearly alternate or lock when the mouth is closed, that it will be best, at present, to consider them as doing so.

The application of these cones to food will be most pene-

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trating, if they close so that the points meet first, and they then slide into their places. The position of almost all the levators of the lower jaw passing, from its back part, backwards and upwards to the skull, will give, as the most powerful mode of accomplishing this, that the jaw be depressed, brought forward, closed and brought backwards and upwards. In this passage, from before backwards, but for some provisional arrangement, there would be great danger of the upper cusps being entangled in the lower, especially as, from circumstances to be hereafter explained, the points are not exactly equidistant or reciprocal, there being more in the lower than the upper jaw.

The further back, from evident reasons of leverage, the greater the power, therefore, the more obtuse may be the points of these teeth; and by thus lowering them there will be less danger of their clashing. To make a still further margin for comfort, and at the same time allow a wider opening at the back of the mouth than a mere ginglymoid action of the joint would give, there is, in front of the glenoid cavity, a prominence which has the effect of depressing the back part of the lower jaw when drawn forward by the pterygoid muscles.

But this depression would not affect the under teeth relatively to the upper unless the plane of the teeth formed an angle with the line of depression; which consequently we find in construction. It is not practicable to measure this angle in the living subject; but I have here an instrument for measuring the angle formed between the plane of two lines drawn from the articulating surface of the condyles to the top of the front lower teeth, and the plane of the teeth, which is near enough for use. Out of a few observations I find this angle to vary from twenty-two to thirty degrees, an arrangement also giving greater power to the muscles by allowing them to act more at right angles to the general plane of the teeth.

This contrivance at the back, and the lower canines closing anteriorly to the upper in front, obviates any danger

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of jarring; the eater in closing his teeth gets his lower canines against his upper, and all the rest must fall into their right places. The canines therefore take important positions as guideposts. May not this function explain the reason of what is nearly a universal law in comparative anatomy, that the lower canines fall in front of the upper; and also may it not have something to do with their late irruption? The teeth come up in such order as best enables them to adapt themselves to each other and their proper place. As an artist in drawing first dots the essential points of his picture, and then fills in the details, first come the first molars and centrals, then the laterals and first bicuspids, then the second bicuspids and canines, and lastly, the second molars and wisdom teeth. If they came up in rotation from before backwards, in consequence of the longer cusps of the canines meeting and keeping the jaws apart, the molars would have longer to grow before they met, and there would have been a great probability of their getting irregular in articulation, or, from the canines having to bear unassisted the force of mastication, they themselves would be thrown out of place. In cases where this occurs we are well aware how frequently the third molar gets into disadvantageous positions.

The scissors-like action of the front teeth, and their use in cutting off pieces of food suitable for mastication, are too simple and familiar to need much attention. Wedge-shaped, I expected to find the angle of the wedge equally divided by the circle of motion, which would give the greatest dividing power; but this is not the case, the angle of the wedge points much more outward in the upper and inward in the lower teeth, reminding us that in closing the teeth, as well as an upward there is a backward motion.

The canines, pointed as well as wedge-shaped, and from their position, a little further back in the mouth receiving more muscular force, are powerful aids to the incisors in dividing such substances as hard fruits, biscuits, crusts, and other splittable matter. A great deal more power falling to

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the bicuspids, they are formed, especially the upper, of two sharp cones or pyramids, capable not only of splitting but of retaining fragments in position, until crushed by the opposing teeth. Here we first meet with a very important element, the guard. If the four cusps of the upper bicuspids of each side alone stood, they would be equally efficient in penetrating power no doubt, but fragments of food would be thrust into the interstices, and jammed there, causing wounds to the gum, or at any rate great inconvenience. A strong ridge of enamel therefore connects the bases of these cones, which act as efficient protectors to the gums against this discomfort.

The most distinguishing feature between the lion and the hyæna is found in this guard. The latter animal—a much more thorough bone-eater than the lion—is provided with a thick, sharp ridge of enamel round the base of his teeth, which shields the gums from splinters of bone that would otherwise endanger them.

The human lower first bicuspid, in which the posterior half alone is opposed to a double-pointed tooth, has a guard on that side only.

The second lower bicuspid is composed apparently of a circular guard running round from the external cusps, and breaking up into one or two small internal cusps. I do not understand its peculiar shape; but the following considerations may explain why it, in common with the rest of the lower back teeth, is flatter on the top of the crown than the upper opposing teeth. Although it is the lower jaw which actually moves, yet from the force of gravity, and the fact that the tongue, which greatly helps in placing and retaining substances between the teeth, moves with it, the food remains on the lower teeth, and is struck by the upper. The lower teeth partake therefore more of the character of anvils, the upper of hammers; so the lower teeth are made more cupped in shape, to retain the various substances whilst struck by the upper. Add to this above, between the tongue and the palate, and not below, is evidently the place

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for the food when squeezed from between the teeth. Therefore channels of clearance, to be hereafter noticed, are cut principally from the upper teeth.

As before mentioned, a bird's-eye view of the lower jaw shows us that the back part of the condyles can be divided into parts of two circles, a larger and inner, whose common centre is outside the front teeth and a smaller outer, whose distinct centres are far behind the last of the back teeth.

When the jaw is drawn to the right, by the action of the external pterygoid muscle of the opposite side, it moves for a short distance, not more, I believe, than the width of half the grinding surface of a tooth in the large circle. On first noticing this action I was sanguine that the side teeth would prove to be arranged on the radii of this circle; and in three skulls which I have measured, it approximated so closely as to seem like confirmation; but I find in some monkeys' skulls, with the condyles on the same plan, the side teeth in parallel rows; so that this appears doubtful.

Whilst there is only this slight lateral motion, of course both sides will move on the radii of the same circle; but, by increasing the action of the pterygoid muscle the left condyle will be brought forward under the zygomatic ridge, and the right will turn on the circumference of the small circle. The combined motion of the circles will thus give the right side nearly a simple lateral action; whilst the left will be moved more downward and forward at the back of the mouth in the front, thus accounting for the fact that the inside of the upper and the outside of the lower are the highest cusps in those teeth, as whenever they are opposed to any extent, the condyle of that side is depressed by being brought under the zygomatic ridge.

The forward motion which is given to one side of the jaw when drawn in, by the pterygoid muscle of that side only acting, will also explain the use of the ridge of enamel traversing the crown of the upper molars in that direction; but this I shall enter on more fully directly.

It is evident that for one curve to move forwards, back-

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wards, and from side to side, within another curve, the inner curve must be the smaller, because we make it retreat an equal distance each side and in front; that is, we cut off it twice as much from the sides as we do in front. The lower front teeth, therefore, must meet in a sharper curve than the upper, and this may explain the relative difference in width of the central and lateral incisors between the upper and under jaws: for if we place lines, representing the relative linear width of these teeth, at equal angles, we shall find those representing the upper teeth make a bolder sweep than the others; though in opposition to this suggestion it may be urged that the kangaroo has large centrals with a very contracted arch, and some monkeys have the lower central teeth larger than their laterals.

The cusps of the lower teeth commencing to alternate in front of those of the upper, would leave, if there were an equal number in the two jaws, the posterior part of the last upper tooth unappropriated. To obviate this difficulty there is a rather complicated arrangement. The bicuspids are too small and simple to allow of much trimming. In the molars the inner cusps alternate above and below; but in the first upper the external posterior cusp is brought forward a little, and as it would then encroach too much upon the anterior cusp, that is brought forward too, diminishing the external face of the second bicuspid somewhat, and giving the molar its characteristic rhomboidal shape.

The forward cusp of the upper molar being outside and rather flattened on its masticating surface, does not interfere with the corresponding part of the lower; but the second outer cusp, from a cross ridge to be considered directly, does; so its antagonizing cusp on the lower jaw is shortened up, and makes room for a small third cusp to be wedged in. By this means the upper teeth are shortened on the outside range, and the under ones lengthened. This fifth cusp of the lower molar locks behind the transverse ridge of the upper molar, which we may remember passes from the outside of the back of the tooth forwards and inwards, the direction

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taken by the lower jaw when the pterygoid muscle of that side alone acts, as before mentioned. In this action the fifth cusp of the lower jaw glides along this ridge.

The second and third molars repeat the arrangement in each case, the lower molar gaining a little on the unoccupied space, until, in the third molar, the back of the upper and lower ranges of teeth are terminated by the same line.

If two opposing teeth be hollowed in their centres, to retain food whilst it is being crushed, their cusps exactly alternating, the resistance made by any substance to their closing would be immense, because it would be confined.

There are, therefore, channels of clearance cut between the cones of all the molar teeth, and from the centres to the out or insides of the bicuspids. The food would squeeze equally through these if of equal size; but we do not want it forced under the tongue, so these grooves are much wider and deeper in the upper than the under teeth, the upper are rounded off, do not fit so regularly, and have larger interstices invading them from the cavity of the mouth.

It is important that the dental organs should be arranged so as to keep sharp as long as possible. Among the lower animals we find many ingenious contrivances for this purpose; that of the front teeth of rodents is well known. Two very opposite methods are well illustrated by the kangaroo and lion. In the latter the two great carnassial teeth are placed like shears longitudinally with the jaw; each opposing blade is trenched into a waved notch, so that bones or pieces of flesh placed between cannot slip forward when bitten. In these teeth the external side of the upper and the internal of the lower slope off, and a deep groove corresponds to the angle of the notch; thus as they wear they sharpen each other and maintain their shape. In the kangaroo the molars are divided into a series of transverse cutting blades, adapted for chopping into short lengths the vegetable food on which it subsists. These blades have nearly the same shape as the carnassial teeth above mentioned, but their form is maintained in a different manner. At the bottom of the hollow

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between the blade at the extreme reach of the opposing tooth, lies a longitudinal ridge, which, by wearing the edge of the tooth which meets it rather more in the middle than it is done elsewhere, keeps it in a hollow shape.

This requirement is partly met in the human economy by the bulging form of the cusps, which, by this form, to a great extent saves their points from friction or concussion; and by the enclosed edges which have to resist the direct force of the bite being made more obtuse than the free edges. Thus, the inner edge of the upper molars and the outer of the lower are much blunter than their respective opposites.

In entering upon the consideration of how best to make dental substitutes satisfactorily fulfil the functions of teeth, it will be convenient to divide the masticatory elements into five heads.

1st. *Elements of Free and Easy Articulation.*—The teeth are to be allowed free motion, up and down, from before backwards, and from side to side, without jarring or entangling the cusps.

2nd. *Elements of Pure Mastication.*—The crowns of the teeth are to have such forms as are best adapted for dividing, splitting, and crushing the food.

3rd. *Elements of Protection to the Gum.*—The gum is to be guarded from injury or annoyance by the food being wedged between the teeth.

4th. *Elements of Clearance.*—Channels of escape are to be made in the teeth, so that they do not choke with the food, but squeeze it out into the most convenient place.

5th. *Elements of Sharpening.*—Arrangements are to be made for maintaining the teeth in an efficient state of sharpness.

An essential part of carrying out these conditions in artificial teeth is to have an accurate bite. This is not always an easy thing to obtain.

With as good a bite as I can get, I strike up the plates, mount the central teeth on each and put on side blocks of deal, with sealing-wax, to carry the springs.

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Having made an appointment with the patient for the purpose, the bite is now rectified. If either piece is for vulcanite, it is modelled in gutta percha instead. In am indebted for many valuable hints connected with this method to Mr. Wm. Cattlin, and find it very advantageous.

There seem no guides, but the lips and expression, to regulate the height of the bite, and the relative height of the upper and lower teeth. The front teeth should be so placed that the lips close without pouting or being strained, without projecting or falling in.

I think the upper and under front teeth should about equally divide the space between the lips when the mouth is opened, so that their edges meet. Yet we often see cases where the upper teeth and gums alone are visible, rarely with the lower teeth more conspicuous.

The upper front six teeth will be chosen on principles dealt with in another place. The lower front six should then be taken of such a size that the canines will shut with their points a little behind the lines between the upper laterals and canines.

Unfortunately, on dental plates the power does not increase as we go backwards; the end of the base would be pressed heavily into the gum if we expected it: this, with the fact that the ascending process of the lower jaw seldom leaves room, makes it advisable to omit the third molar. The eight bicuspids should be the same width. The two first lower molars may be rather wider than the others, which should be equal.

Some of the profession, I believe, make their own teeth, and it would be easy for them to carry out the elements of mastication, relative to the forms of the tops of the teeth, in a much more efficient manner than I have been able to do. But most, I believe, use manufactured teeth, and it is one of the objects of this paper, that if this Society endorses my belief in the need for them the manufacturers might be induced to supply improved forms in back teeth.* The upper

* Since the above was written there has been great improvement in the masticating surfaces of manufactured teeth.

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canines, too, we want a good deal deeper from the labial to the lingual surface for the lower to run against as guide-posts.

Having chosen the front teeth, arrange the upper six according to the arch of the mouth and taste, and mount the lower six in a smaller curve, so that they bite within the upper. Mark the spot on the plate it is intended to carry the teeth back to—say within one third of an inch of the ascending portion of the lower jaw—and choose back teeth, in the before-mentioned proportions, to fill up the space; let the first bicuspids continue the arch with the front teeth, and place the others in a straight line back to the mark. The last tooth in the lower will probably fall rather to the inside of the remains of the alveolar ridge; but this is another point for which I can find no definite guide.

By means of this bite-frame, which has been shown to the Society before, the teeth can be placed in the right plane. The angle which the plane of the lower gums forms with the plane of straight lines drawn from the condyles to the front of the gums, is measured; also the distance of the front of the gums from the condyles.

The lower model is then placed in the frame, in the same position relatively to the centre of the hinge; and the upper is fixed in the top saucer of the frame, according to the rectified bite previously taken.

The lower back teeth are now mounted, and let down so as to make the angle of their plane, with that drawn to the condyles as before mentioned, as nearly twenty-six degrees as convenient.

To fulfil the second conditions, those of giving the best masticating surface to the teeth, cut away the front half of the inside cusp of the lower first bicuspid, and make as clean a notch as possible into the top, leaving the inside cusp much lower and blunter than the outside; then carry the wheel round to the back, so as to leave a guard a good deal lower than the cusp. The second treat in the same manner, leaving two guards. The upper bicuspids divide more deeply and

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equally, but still leaving the outer cusps sharper and higher than the inner.

Among other notable differences between an ordinary porcelain molar and a natural one, we shall notice that, whereas the distance between the points of the outer and inner cusps of the natural one is scarcely ever more, often much less, than two thirds the thickness of the body of the tooth, in the artificial tooth the top, we will not speak of its cusps, is very nearly as wide as any part, thereby incommoding the tongue, thickening the speech, and requiring increased power to force it into food. Having less, instead of greater, power on plates than on fangs, I have found it advantageous to bring in the width of the tops of the molars to half that of their crowns, taking it principally off the inner side of the upper and the outer of the lower teeth. Now cut a deep furrow as sharp as possible, dividing the tops of the teeth longitudinally, and passing rather nearer to the inside of the lower and the outside of the upper, and leaving the inside of the upper and the outside of the lower the higher sides of the teeth. Cut a similar notch across the middle of the lower molars and take a little off their ends, so as to leave pyramids having their angles, except their points, a little rounded. The upper molars should have their anterior inner and posterior external angles rounded off somewhat, so as to give their faces a rhomboidal form, and they should then be cut into cusps, similar but a little sharper than the lower.

The teeth may now be mounted to the bite, the lower cusps falling into the same places relatively to the upper as in the natural organs, as before described.

If there seem not to be sufficient channels of clearance, enlarge them by rounding yet further the anterior inner angle and cusp of the upper molar and deepening the divisions between the cusps generally in the upper set.

Porcelain teeth are so hard that there does not seem any necessity to pay further attention to means for preserving them sharp; and the base on which they are mounted generally serves as sufficient protection to the gums.

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MECHANICAL DENTISTRY.

CHAPTER I.

ON REGULATION PLATES.

In the 'Proceedings of the Odontological Society' for February, 1874, appeared a paper by Mr. Caleb Williams on a method of working vulcanite by packing directly on the model instead of preparing a wax core, flasking, and pressing as usually done. This paper seems hardly to have met with the attention it deserves. To it I am indebted for the following way of packing regulating pieces, to which it is especially adapted.

The plaster model is not dipped in wax but dried, and, whilst warm, coated by a camel's-hair pencil with a chloroform solution of uncooked rubber. I generally use the "whalebone." This coat is laid on whilst the model is warm to promote the evaporation of the chlorotorm, which makes the rubber spongy if any remains; the solution should be carried wherever the plate is intended to go.

A pattern in sheet lead having been previously prepared a plate is cut by it out of the soft rubber, which is placed upon the model and carefully pressed with the forefinger into all the inequalities of the impression. The rubber will be found to adhere to the previous coating with the greatest tenacity, therefore a little care is necessary in placing it

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in position, as after touching the model it cannot be shifted. This can be done by doubling the soft pattern over the end of the right forefinger, and placing this on the middle of the palate; the two wings can then be brought down and gently pressed into place. Any part that requires strengthening or thickening to carry plugs, &c., must have rubber added, just as in the ordinary method wax is built upon a wax core. The piece is now smothered in plaster, placed in a flask, filled up, and when the plaster is set vulcanised. The process up to the vulcanising occupies from five to ten minutes instead of one or two hours. There is no straining of the model in any way, the fit is exact, and slender teeth and undercuts, which, to say the least, make a difficulty ordinarily, are thus fitted with ease.

The following case is given in illustration of some different methods of applying force with vulcanite regulation frames:

About two years ago Mr. B—, a medical man, brought his son for advice with the following irregularity:—On the right upper side were two well-developed lateral incisors. The hindermost of these occupied the place required by the canine of that side, which could be felt under the gum outside and above it. All the bicuspids were in place and both the upper first molars.

The presence of the supplemental lateral, with the pressure of the approaching canine, had thrown the centrals, large, long, prominent teeth, much to the left of central line of the mouth. The left central incisor was rotated rather more than the eighth of a turn so as to make its cutting edge parallel with that of the right. The left lateral was thrown inwards and backwards, and the left canine, the point of which was just through the gum, outwards and forwards, so that the middle of the labial surface of the lateral was just behind, and almost touching, the middle of the lingual surface of the canine. The teeth were very prominent, and the effect very disfiguring, and as the first molars were already

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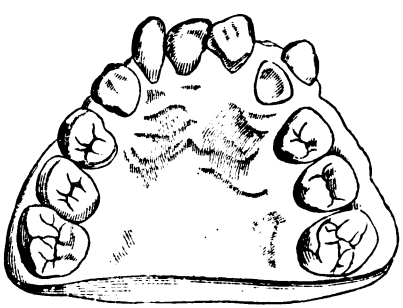
decayed the first step was to remove them as well as the posterior right lateral, with the intention of presently proceeding to reduce the teeth to symmetrical positions. Mr. B—, however, hoped that what had been done would allow nature to rectify matters, and delayed to bring his son again until September, 1875, when very little improvement having taken place he again came into the hands of my partner Mr. Coles and myself.

The advantage we hoped to have gained in space at the back of the mouth by the extraction of the first molars, which would have allowed the bicuspids to be moved backwards, had been in some measure lost by the delay, as the second molars had filled their places. His mouth presented the appearance of Fig. 1.

FIG. 1.



Model of Mr. B—'s mouth two years after extraction of right lateral and both first molars.

The right canine had come down in its right place, although still rather short. The left canine had come down a little, but was not altered in its position relatively to the lateral. The centrals showed a disposition to improve by moving towards the right. The right lateral was still very prominent.

A plate was made to cover the palate, cap the molars and bicuspids, and come down outside them an eighth of an inch on the gum. It was not allowed to fill the gap between the

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left lateral and bicuspid, but at that part the palatal rubber was carried up rather higher than the tops of these teeth in order to carry a hole for a plug of compressed wood. The plate was filed a quarter of an inch back from the right lateral to allow this tooth to move in (see Fig. 2).

Fig 2.

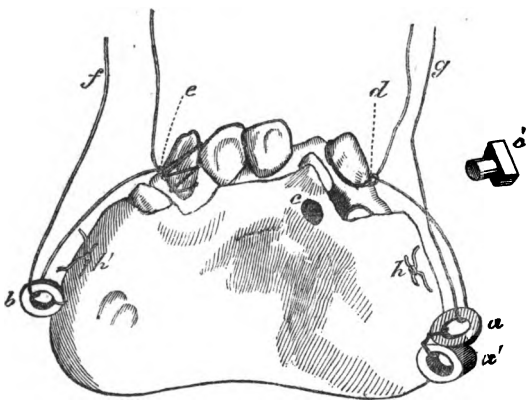

Diagram showing reg. plate tied in the mouth to the second bicuspides, *h*, *h'*; with ligatures from lateral and canine (*e*, *d*) passed through elastic rings (*a*, *b*) previous to drawing them up and tying.

The elastic rings used were cut from the black india-rubber tubing sold with Maw's feeding bottles for the nursery.

In order that a frame may act efficiently in a case of any difficulty it is important that it should be firmly tied in the mouth. Fig. 3 illustrates the method adopted.

In the diagram the roots of the teeth are indicated to give a better idea of their position, and a small piece of the vulcanite plate is supposed to be cut away from the left-hand figure to show the tie underneath.

The second bicuspid being chosen as the most convenient tooth for the attachment of the ligatures, holes are drilled through the outside of the regulation plate about a quarter of an inch apart, so as to enter the impression of the second

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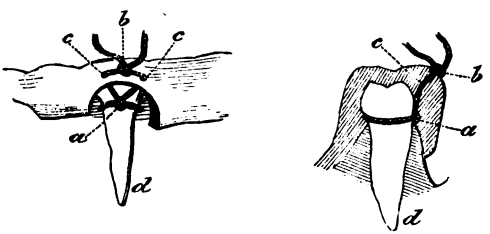
bicuspid nearly at the place to be occupied by the highest part of its outside cusp, that is, in the deepest part of the impression (see Fig. 3 *c c c*). Fine mohair is passed around the neck of the tooth, and tied tightly on the outside at the margin of the gum in a knot (Fig. 3 *a a*). The fellow tooth on the opposite side of the mouth having been treated in the same manner the loose ends of mohair which have been left about six inches long on purpose are threaded through the holes (Fig. 3 *c c c*) in the regulation plate, which is then slid

FIG. 3.



Method of tying reg. plate firmly in the mouth. The ligature is first passed around the neck of the tooth and tied on the outside at *a*, the loose ends are then passed through the holes in the plate (*c*, *c*) and tied at *b*.

up the ligatures into its place. The patient is now directed to bite hard; the ends opposite each tooth are drawn tight, tied (Fig. 3 *b b*), and the superfluous ends cut away.

Before the plate was put into position, however, holes were drilled at the posterior ends on the outside and an elastic ring, made by cutting a quarter of an inch off the black elastic tubing sold with Maw's feeding bottles, tied on at each end (Fig. 2 *a b*). A square-headed peg of compressed wood (Fig. 2 *c'*) was placed in the hole (Fig. 2 *c*), so that in expanding when in the mouth it should drive the left lateral and first bicuspid asunder, and virtually, the bicuspid being supported, drive the lateral towards the central. A ligature was .then placed around the canine. This tooth was not fully through the gum, which was therefore slit to allow of

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the mohair being pushed under it until a firm hold of the tooth was obtained. I may here remark for the sake of young practitioners that this is more easily done than appears probable, as there is no adhesion between the gum or periosteum and the enamel of any tooth.

The right lateral was a very long and prominent tooth; it seemed, therefore, desirable to pull it from as near the top of the crown as possible. This was done by beginning at the neck and crossing the ligature to and fro, tying a knot at each angle of the zigzag, as seen Fig. 2 *e*.

The mouth and plate being now both ready to be brought together the end of one of the ligatures on the lateral (Fig. 2 *f*) was slipped through the elastic ring *b*, also one of those on the canine *g* through the ring *a*.

The ligatures for tying the plate on to the bicuspids were threaded in their respective holes as previously described, and the plate placed in the mouth and tied by them (Fig. 2 *h*).

By drawing upon the ligature (Fig. 2 *f*) the elastic *b* was brought up to the knot *e*, and whilst held there by a blunt instrument tied. The same thing was now done to the canine on the other side by drawing upon the ligature *g* and tying it at *d*. The distance between the knot *d* and the knot which tied the elastic *a* on to the plate was one inch and one sixteenth, and the stretch of the elastic on the other side was the same. The patient was now dismissed for a week on October 5th, 1875.

The boy being at school fourteen miles away, it was arranged for him to pay us a visit once a week. In regulating cases I have found this lapse of time between the visits more satisfactory than oftener. When a patient attends every two or three days little advance is perceptible, his friends are anxious to hasten matters and the operator is worried to do something more. The plate is removed to put new plugs or elastics, and a great deal of time and trouble is spent for which it is doubtful if any adequate return in expedition is made. It is probable, as I think is mentioned

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in Tomes' 'Dental Surgery,' that in moving teeth by mechanical pressure, physiological laws are brought into action. Teeth are not forced through the bone as through a semiviscid substance, but the pressure produces irritation which arouses the vital constructive principle residing in the bone to make way for it by absorption, a fresh socket of new bone being formed around the tooth when the pressure is removed. Bones grow in this manner, the old is absorbed and new formed; and in regulating teeth we often find that little progress is made until the teeth become tender and loosish, when they move rapidly, but become firm again on being allowed rest.

Whether or not this is the correct explanation, I find in practice that those cases do best where sufficient pressure is put upon the teeth to make them tender, and a week allowed to pass between each renewal or alteration of the plugs, &c.

In the case under consideration, at the end of the second week the left lateral had made good progress forward, allowing the insertion of a larger plug. The right lateral had also moved backwards, but rather too much outwards, therefore the elastic attached to it was shifted to the palatal side of the second molar so as to pull from inside instead of outside the arch of the teeth. As the left canine had made very little movement the strain on it was doubled by tying another elastic to the frame at the same place as the first (fig. 2 *a'*). This is more manageable than putting a ring double the strength of the first. Two ligatures are attached to the tooth, and each ring drawn up and tied separately. The teeth now made rapid progress from week to week, the peg and elastics being occasionally changed.

An attempt was made during one week to move the central incisors to a more median position; but as the left lateral advanced towards them, and the right lateral was withdrawn, they showed so kindly a disposition to regain their central position that further aid became unnecessary.

As a tooth approaches another under pressure, a pucker of gum is heaped up between them. This, no doubt,

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absorbs in time, but it is better to remove it, as it is very tough and resistant. This can be done by a pair of fine-pointed scissors, but I more often use and find very convenient a gouge-shaped lancet, made by sharpening the wrong end of a common steel pen. To make it, thrust the writing point of a pen into the holder, and then holding the concave side on the hone, the holder forming a very acute angle with its surface, fret away the pen until the middle line of its back meets the surface of the hone.

In five weeks the left canine was almost touching the bicuspid, and nearly the whole of its crown was through the gum, the left lateral was nearly touching the central, the right almost touched the canine on that side and was closely followed by the centrals.

It being now deemed advisable to try and bring the left lateral more out into the range of the teeth, it became a question for consideration whether it was better to draw it by an elastic or push it by compressed wood. The tooth being comparatively short, it was decided to draw it out by elastics, as compressed wood acting on the inclined plane of the back of an incisor has a slight tendency to thrust it farther into its socket as well as outwards.

The plate, fig. 4, was therefore made, and fitted and tied in as the previous one. It carries a band of vulcanite, *a a*, in front of the incisor teeth without touching them; this was about half an inch deep and the tenth of an inch thick; it passed in front of the left incisor at a distance of a quarter of an inch. Through this band a hole was drilled at *b*, just opposite the tooth and rather above the line of the gum, so that the strain of ligatures passed through it to the lateral should be rather upwards as well as outwards. The outside edge of the hole at *b* was well countersunk, rounded, and polished, so as to give as little friction as possible to the ligatures; there *f f* and *e e* having been previously tied to the lateral were brought through the hole *b*, passed through the elastics at *c* and *d*, which were then stretched up to *b* and tied.

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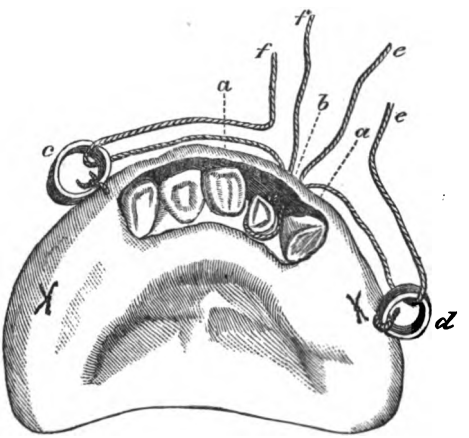
In two weeks this had brought the lateral quite far enough forward, and it was determined to proceed to rotate

Fig. 4.



Method of drawing out incisor. The ligatures *e* and *f* are drawn until elastics *c* and *d* are stretched up to *b*, when they are tied.

the left central. The father of the boy, although strongly urged, objected to the use of the forceps, and therefore a plate was used. The method figured in Tomes' 'Dental Surgery,' p. 160, was adopted, except a vulcanite instead of gold plate was used. The vulcanite was made to fit nearly up to the top of the front teeth both inside and out, covering the back teeth as before. A chamber for compressed wood was cut opposite the internal medial angle and external distal angle of the left central, and the vulcanite was cut away from opposite the other angles to give the tooth room to move round in. The plate was also cut away from inside the left canine, and a slit for wood cut outside in order to drive it in. The plate was tied in and the wedges driven in. A hole was also made through the plate just opposite the left canine inside, through which ligatures were passed from it and tied to two elastics, one fastened across the palate

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close to the right lateral, the other on the same side, just inside the molar.

By December 7th the left lateral was nearly in position. The lad was going home for a month's holiday after his next visit, and it was not desirable to leave continuous pressure on any of the teeth for so long a time without oversight. A model was therefore prepared by adding a little plaster to the teeth on the correct model in one place, and trimming it away in another, until a new symmetrical range was produced. A plate was made capping these. This when placed in the mouth would not quite go down, but it would prevent the teeth reverting to their original positions and have at the same time a beneficial tendency. He was directed to wear it constantly until it went up into its place, and then only at night.

On January 17th he again made an appearance with so great an improvement that little remains to be done. The left canine is a little prominent and the right lateral too long. As the arch of the teeth will not allow of the canine being brought in, further space will have to be made in some way, possibly by sacrificing the left second bicuspid; and it may be necessary to shorten the right lateral with the file; but as the description of the further details will be tedious rather than interesting, I will conclude it here.

Whatever means are used in moving teeth, a firm stationary point of attachment or resistance is necessary. When several teeth are capped by the plate this is approximately attained; but the operator must bear in mind that whatever point supports the force which he employs has to sustain as great a strain as that part which he desires to move.

This is well illustrated if we take for example an upper lateral which bites within the lower incisors. In this case the back teeth being capped to keep the mouth open so that the lateral can move forward uninterrupted by the lower incisors, the plate is brought up behind the lateral, and

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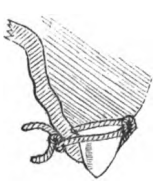
thickened there for a chamber to be cut which receives a block of compressed wood. The plate being tied in, the wood begins to swell and press forward the tooth, but it also raises the plate and tends to draw the teeth to which it is attached out of their sockets. The molars might bear the strain, but they are so far back that, if used, a considerable amount of *giving way* will take place before the real work begins to be done. This "giving way" arises from the elasticity of the plate and ligatures, which can never be made theoretically rigid.

The attachments most advantageous for the sake of the lateral are the canine and central on the same side, but they will certainly be lengthened by so using them. For this reason in most cases we shall avoid attachments to any of the incisors. But if the canines are not quite down and rather projecting, as is often the case, we shall do no harm by making use of them.

In tying a tooth to the plate when it does not cap it: first tie the ligature around the tooth with the knot on the outside close to the gum; then, having two holes drilled through the plate just inside, and opposite where it lies against the tooth, pass the two ends of the ligature through these holes from the under side, slip the plate into its place, and tie them on its lingual surface (see fig. 5).

FIG. 5.



Method of tying reg. plate firmly to upper canine.

It is much easier to tie the ligature to the tooth with the knot on the outside than on the inside, and it then holds the plate much more rigidly in its place; whilst if you

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simply pass it through the two holes and around the tooth you have an insecure fastening.

When teeth are too crowded it often happens that the canines, not finding room to wedge themselves in, appear high up on the outside of the gum. If the mouth is otherwise healthy and well developed, the extraction of a bicuspid on each side may be all the interference required at our hands; but should the first molars be diseased, this will indicate their removal. Under these circumstances it is often necessary to use a regulating frame; or the canines may not have power enough to move back the bicuspids before the second molar, which, as we have seen in the case of Mr. B—, advances rapidly, has usurped the place of the first molar and checked the backward movement.

To make a plate for such a case, cover the palate with one thickness of rubber, bringing it up to the necks of the teeth but not capping any of them. At the gaps between the laterals and bicuspids carry the rubber up, as if the canine were in its right place, making a sloping plane a quarter of an inch high. Through this drill a hole opposite the middle of the vacancy, to carry a square-headed peg of compressed wood (see fig. 2, in Mr. B—'s case).

It is well to have on hand rods of some soft wood half an inch square. I have used willow, deal, and plane. Willow answers best. Cut off an inch from one of these rods. Place this in a vice with the grain parallel to its jaws. The softer woods can be screwed up to nearly one third of their former diameter; the plane not so much. From this compressed wood cut the pegs. In order to ensure that the pegs are placed with the grain in the same relative position to the sides of the teeth between which it is placed, as it had to the sides of the vice, it is well to mark one side of the wood with a pencil, and keep the mark undisturbed whilst cutting the pegs.

Drill the holes in the plate in such a direction that the peg shall press rather hardly into the gum, as it is advantageous to press the teeth from as low down as possible;

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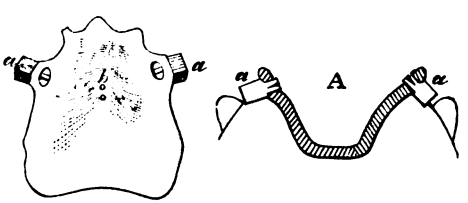
partly because the power of the peg is in proportion to the amount of wood acting, and perhaps partly because it sets up a little beneficial irritation. This must not be overdone: it is only meant that the wood should rather press on the gum than be just touching (see fig. 6). A little wedge of wood driven into the small end of the peg after it is in the plate will hold it firmly, and prevent your being annoyed by its coming out and being lost on the carpet when fitting to the mouth with file or penknife (see fig. 6, A, *a*). The pegs may be changed twice a week whilst the space is very narrow, as the amount of wood being small we must make use of every little gain until a peg of some substance is admissible, when visits of once a week will be preferable.

When sufficient space to admit the canines is gained, the same plate will suffice for drawing them into it.

A stout elastic ring, got by cutting off a quarter of an inch from the black rubber tubing sold by druggists for enemas, is tied by the middle to the centre of the palatal portion of the plate (see fig. 6, *b*). Tie ligatures to the

FIG. 6.



Method of pushing back bicuspides after extraction of first molars to give room for canines.

canines, and pass one end from each of these through the holes previously occupied by the pegs, through the loop of elastic nearest to it and back, again through the same holes. The elastic is then stretched up to the holes by drawing on these ends, and the two ends of the ligatures being tied keep it there, by its reaction to draw in the canines (see fig. 7).

It will not be necessary to tie this plate in the mouth

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when using either wood or rubber, as in each case these tend to keep it in place.

The arch of the incisors supports the pressure in front, so that we need not fear their forward displacement.

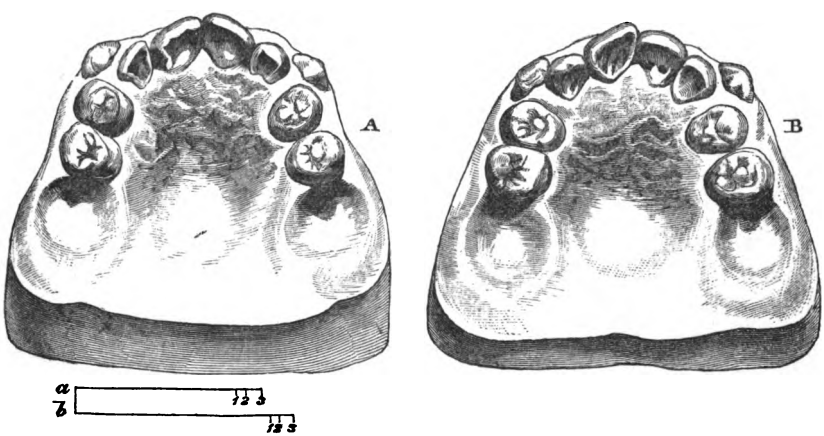
Fig. 7.

Method of drawing canines into place with same plate as Fig. 6.

The following may be taken as typical cases, and are interesting on other considerations:

The two Misses D—, twins, presented the conditions indicated in a singularly similar degree, as will be seen by reference to the drawings, fig. 8. These are from models taken

Fig. 8.



Drawings to scale of the models of the mouths of twins. The distance between Figs. 2 and 3 on the lines *a* and *b* shows the increase in the spread of the mouth after two years.

two days after the extraction of the first molars, all of which were decayed.

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These models were taken January 8th, 1874, and the cases finished with the canines in place by the 18th of the following February. The greatest space gained being, on the right side of A, from one eleventh to three tenths of an inch, the other gaps being originally a little wider, the teeth had not quite so far to travel.

I have just taken their models again (the middle of January, 1876). These are now before me. The second molars have entirely taken the place of the first without any apparent leaning forward, but the teeth look as if slightly moved round and forward, using the palatal fang as a pivot. The space gained for the canines has been maintained, yet still the teeth are a little crowded; telling us to bear in mind, after the removal of the first molars has been decided on, the second molars not being visible, that the determined advance of the latter makes the time for the extraction of the former a matter for consideration.

I was not prepared to find so great an expansion of the arch of the mouth between the bicuspids as these mouths present.

Under A, fig. 8, are given the actual widths, measuring to the nearest points of the bicuspids across the mouth at the margin of the gum.

Fig 8, *a* 1, is the width between the first bicuspids before regulation was commenced; *a* 2, is the same measurements after regulating; *a* 3, ditto at present.

Fig. 8, *b* 1, 2, 3, are similar measurements between the second bicuspids; showing a gain since the plates have been left off of one twelfth of an inch.

When all the six upper front teeth close within the lowers, making what is called an underhung mouth, we may under favorable circumstances attempt to reduce them to their proper relative positions.

Mr. Tomes recommends pushing out only two teeth at a time, keeping these stationary whilst the next two are being acted upon, and so on. But he does not suggest the means for doing this, and in my experience it is inconvenient. Sup-

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posing two hickory pegs are substituted for the blocks of compressed wood which have pressed out the two centrals, in order to maintain these in place, whilst similar blocks behind the laterals push them out in turn. So soon as these blocks begin to swell and push upon the laterals, the plate will be a little raised, however tightly it has been tied in, the hickory pegs will be withdrawn from the centrals, which will immediately commence a retrograde march.

On the other hand, if we attempt to press out all six teeth at once, depending for our resistance on ligatures to the first or second bicuspids, these teeth will be greatly elongated by the accumulated strain of six blocks of wood swelling at once, whilst the first molar is so far from the teeth to be acted upon that a great deal of power will be lost, if it is used for attachment, from that *giving way* which the elasticity of plate and ligature always manifest under strain.

These difficulties were met in the mouth of Miss M— in the following manner:—The young lady had been wearing a plate capping the lower teeth, and bringing an inclined plane over the lower front teeth so as to bite within the upper, for about a year, when she came into the hands of my partner Mr. Coles and myself. This method was therefore negatived, and it was determined to attempt pushing out all six front teeth at once.

A plate was made capping all the back teeth, and thickened behind the crowns of the front teeth where chambers for compressed wood were cut; and in order to utilise the closing pressure of the mouth, the edge of the plate was continued beyond these chambers downwards and outwards so as to make an inclined plane for the lower front teeth to bite within and against.

The plate was tied to the anterior bicuspid on each side; but to give a grip to the plate so as to reinforce the holding power of the ligatures, the wedge-shaped interspaces between the back teeth were deepened on the model before the plate was made, taking care to keep the sides of the cuts perfectly perpendicular.

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Fig. 10 is a horizontal section of these teeth on one side of the model, the shaded parts being supposed to be what was cut away, but rather exaggerated to give a clear idea of what is meant. By this means a very firm grip was given to

Fig. 9.

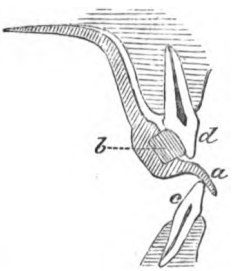

Fig. 10.

Fig. 9.—Section through upper and lower incisors, the plate being in place. *a*. Vulcanite plate. *b*. Block of compressed wood. *d*. Upper incisor. *c*. Lower incisor.

Fig. 10.—Method of making reg. plate hold firmly in mouth without tying. Outline of teeth, on model the dark spaces are cut away before the plate is made.

the plate which, although it was lost after the third removal, started the teeth well and enabled the case to be successfully completed in about five weeks.

When an incisor above or below is crowded outside the range of the teeth, it can be brought in, and the adjacent teeth pressed aside to make way for it, very advantageously, by a straight piece of elastic interlacing them. A plate must be made which may cap the back teeth and come across the mouth behind the tooth to be operated on, leaving room for its inward progress. Holes are drilled as near the proximal edge as is convenient, about half an inch on each side of the offender.

Take an elastic ring, such as can be purchased at any stationer's, about a quarter of an inch in width, and as thick as a shilling. Cut a piece from this of such a length that when its ends are tied at the holes previously drilled it will lie a little stretched between its attachments. The plate is

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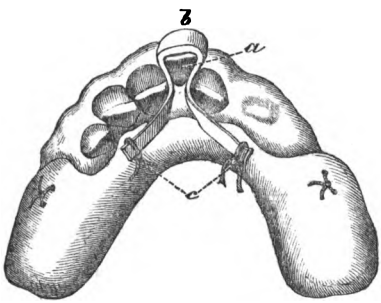
now tied in the mouth to any convenient teeth, the elastic lying across the gap behind the prominent tooth. With a blunt instrument draw it through this gap, and slip the loop thus formed over its crown. Should there be any tendency to slip off it can be tied by a thread embracing crown and elastic diagonally.

Fig 11 shows a bird's-eye view of such an arrangement for the lower jaw. *a*, central incisor; *b*, strip of elastic rubber fastened to the frame at *c c*.

FIG. 11.



An excellent method of getting a tooth into position when crowded out. If the tooth is inside bring the plate further forward on the outside and reverse position of elastic.

It is exceedingly easy to make a vulcanite plate fitting the crowns of all the teeth as accurately as the impression, by Mr. Williams's method of packing the rubber directly on the model. This offers us therefore a very satisfactory means of ensuring the stability of whatever changes have been made in the mouth. A plate should be made of an even layer of vulcanite, capping all the teeth to the edge of the gums on the outside, a little deeper than this on the inside if in the lower jaw, and covering the palate if in the upper jaw. This plate can be removed and cleaned by the patient, who may be directed to wear it at night only, for six months; after which time trying it in weekly for a short time, to see if any retrogression takes place.

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When a tooth has been rotated by the forceps it is sometimes necessary, and always satisfactory, to ensure its permanence in its new position by means of such a plate, capping it and the adjacent teeth.

As an illustration I will give the case of Master H—, who had an upper lateral with its cutting edge at right angles to its proper position. This was complicated by an abnormally developed lingual cusp indicating a flattened fang, which made the success of any interference doubtful; but as in its then condition it was very disfiguring it was concluded to make the attempt and risk the loss of the tooth. It was first extracted, and a good deal of the lingual side of the fang filed away, so as to reduce its shape to a more nearly cylindrical one, care being taken not to interfere with the membrane covering the end of the root.

When the tooth was replaced in the mouth a slight touch would have slipped it back into its former position. Therefore an impression was taken in "extra soft" Godiva composition in order to make a vulcanite cap. And whilst this was preparing a gutta-percha splint was worn. It took three hours to get the vulcanite piece ready.

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CHAPTER II.

ON ADDITIONS AND REPAIRS.

Little space is devoted by the text-books to the subject of adding to or repairing old pieces. It is either considered of too little importance or supposed that the methods laid down for making new work will be sufficient indication of how to deal with such cases.

Yet repairs and additions form an important item in every practice, if well done give great satisfaction to the patient, and differ from new work in many important points as to the modes of procedure to be adopted towards them.

In gold work, the first and most important of these is, that, when about to add to an old piece, the model must be taken with the piece to be added to in the mouth. This must be taken from the mouth in the impression, into which the plaster must be poured with the plate still there, so that when the model is drawn the piece will appear on it, holding exactly the same relation there to the gaps to be covered, that it does in the mouth.

A little consideration will show us the necessity for this. For many years I used to take a model of the mouth, strike up the new piece of plate by it, and fit it to the old one on the model so as to make one piece as nearly correct in fit as possible; sometimes having to cut off all the pins, &c., from the old piece and strike both together. This was altogether wrong. The old plate cannot be got down on the plaster model like it is in the mouth. The first being of a uniform and tolerably hard consistence; the second being composed of, the teeth, very hard but more or less movable

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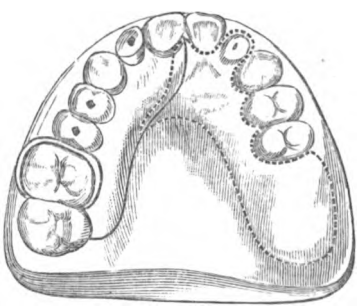
bodies, and the parts covered by mucous membrane which are of variable softness.

We must not interfere with the fit of the old piece if it is comfortable; but if we are to undertake the trouble and responsibility of a new fit, we shall save little in labour or material by restriking the old plate, and had better make a new piece at once. Let us suppose that a patient presents himself under the following circumstances:—He is wearing a gold plate on one side of his mouth, supplying substitutes for the right upper lateral and both bicuspids (see Fig 12).

FIG. 12.



Model with old plate on it ready to cast, in order that a new piece of plate, indicated by the dotted line, may be struck up to fit and then soldered to the old plate.

The left molars have been long absent; but were not supplied when the plate was made from reasons of economy. The crown of the left lateral having broken off from decay, he now wishes all the deficiencies to be restored. The clasp around the molar being opened to permit of the easy withdrawal of the plate, a model is taken with the piece in the mouth, as previously mentioned. After the plaster cast is poured and drawn, the plate is removed whilst it is dipped, but replaced previously to casting it in sand for the zinc dies. Any overhanging parts likely to make drags being freely waxed up. A piece of gold plate is now cut out by pattern so as to strike up to the dotted line on the model (see Fig. 12), thus overlapping and fitting the old plate. The latter

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is now loosened from the model which is trimmed until it will easily remove, the teeth are taken off it, and the plate is cleaned. The two pieces are to be placed in position on the model, and cemented together so firmly that in moving they may run no risk of being shifted. They may now be placed in an investment of plaster and soldered. I say may be placed in plaster because it is much quicker and cleaner to do it in clean casting sand, but it requires more care; and some experience had better be acquired in soldering in sand alone with smaller matters before attempting such an important job. The completion is to be carried on as of a new piece of which half is already done.

We will now proceed to the consideration of cases where a single tooth or isolated teeth require to be added to the plate. It frequently happens that there has been a band or collar round the neck of the absent tooth; before taking the model this must be cut away and the plate filed back until its edge is flush with the gum in the mouth. It is better not to attempt to let the plate of addition rest upon the gum so as to bear any of the pressure of the piece. The plate is already comfortable and large enough to bear the strain of mastication thrown upon it, the addition will probably not make an appreciable difference; the new tooth or teeth are wanted for appearance, if front teeth, or if out of sight, to prevent food getting under the plate incommodiously. The importance in expedition to the patient, who has often, in the mean time, to face the world with unsightly gaps, is greater than will be recompensed if we attempt great accuracy by striking up such small pieces of plate. It will be sufficient if the gold added lies approximately close to the gum without resting upon it at all. This can be obtained by cutting a piece of gold to fit by a lead pattern, so as to overlap the old piece a little, and bending it with pliers until a tolerably accurate fit is obtained. The patch is laid on the plate on the model and the two securely stuck together with resin and wax (the sticks sold by Messrs. Ash for mending broken models, &c., answer very well). They

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are then lifted off together and soldered on sand. Soldering on sand has been before alluded to, and as it requires some precautions it will be described a little more fully.

A handful of light moist sand, just in a state to cast with, is deposited in the hollow of the casting coke. The two pieces of gold to be soldered together are placed upon it, having been previously stuck together in their right relative positions, as previously spoken of. They are gently pressed into the sand so as to be supported underneath, everywhere steadily, care being taken not to disturb their relative positions. The sand is pressed down around them so as not to be blowing loosely about when the blowpipe is used, and none is allowed to remain on the upper surface. The flame is now at once applied with the blowpipe until all the cement has disappeared. With a very light hand place a piece of No. 1 solder on the most convenient part of the joint, but put no borax; this must now be run with the blowpipe so as to hitch the two together. If borax were used it wou d shift the pieces in rising when heated, sand not being strong enough to resist it. This is the point in soldering in sand, which requires more care than soldering in plaster; it is soon learned, and the advantage in time and cleanliness only needs trial to be appreciated. After hitching one point with solder, borax may be freely applied, and the soldering completed. This method can be used in almost all cases where two pieces of gold have to be joined in exact relative positions, such as mounting clasps, &c.; but not in putting up flatbacks, as it is not convenient for the gradual heating they require.

The deficiency of the base plate in the gap having been supplied a tube tooth can be mounted on a pin in the usual manner.

If, however, the place of an absent tooth is to be supplied by a flatback, a different proceeding is more expeditious and satisfactory. The tooth is chosen, backed with gold, and fitted to the gum, and adjoining teeth in the mouth.

A piece of modelling wax, such as is ordinarily used in

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vulcanite work, the size of a hazel nut, is softened and pressed into the gap in the plate in the mouth, so as to take the impression of the gum; and whilst still there, the backed tooth is pressed into it to occupy its correct position. The plate carrying the wax and newly backed tooth is removed and invested in plaster for soldering. When set, pour boiling water upon it to remove the wax. The tooth will now be in its right position relatively to the plate, but between the two is a gap containing the plaster model of the gum. This is usually very small, and a little semicircular piece of plate is cut out and fitted so as to drop into the void space. The whole is to be warmed up gradually, and patch and tooth all soldered together at one heating. A little care is necessary to let the solder hitch the little loose piece of gold to the plate first, before the solder attaching it to the tooth runs; as being very small it is apt otherwise to shift up towards the tooth.

When a vulcanite plate is broken in two it can often be well repaired. The first step towards this is to get the two pieces fixed together in their correct position. If the pieces are not quite separated, and we do not suspect that the fit has been spoiled, the crack should be sealed up with wax, and the piece placed in plaster in one half of a flask so that it makes a model of that part of the plate which fits the mouth. Should the plate be in two parts the crack is generally clean and affords sufficient indication for getting the true apposition. The pieces must be steadily held together whilst sealing wax is dropped over the lingual surface until it is of sufficient thickness to hold the two pieces rigidly whilst being put into plaster. But if the surface of the thickness of the plate in the crack is very small and plain, and we fear that it is not sufficient guide in getting the right spread of the piece, instead of using sealing wax use a cement of wax and resin (Ash's sticks). This if laid on pretty thickly, say a third of an inch, will be sufficiently stiff under light handling. Place the piece in the mouth and by steady pressure bring it into its proper fit, then

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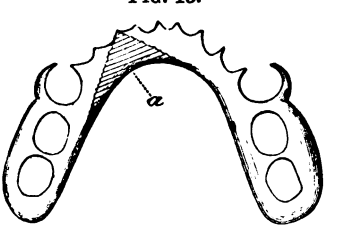
remove and place in plaster as before described. If there be a metal strengthener in the piece which has been bent when the vulcanite was broken it may be impossible to bend it into its right position again, the vulcanite preventing the metal from being bent enough to compensate for its own spring. This is sometimes rectified by cutting the vulcanite away on each side the crack before attempting to bend it right, trying it in the mouth before embedding it in the plaster. It is, however, generally better to separate the two pieces. Cut the strengthener out of one side first; it can readily be removed from the other by holding the detached end of the metal in the gas flame until it is hot enough to draw out. The two halves can then be proceeded with as before.

Supposing them in their right relative positions invested in plaster all but the lingual surface in the lower part of a flask. The crack must be cut completely out, the vulcanite sculpered away in a long incline towards it from two imaginary lines running parallel to the crack from a third to half an inch on each side (see Fig. 13). Although new vulcanite

FIG. 13.



Drawing to show the least amount of new rubber which should be used in repairing a broken piece.

when cooked in contact with a clean rough surface of old, unites so intimately with it, that I am not sure it does not make the joint as strong as an unmended piece, still we should always give it every advantage. The new vulcanite is probably stronger than the old, as in the ordinary run of work every baking more or less deteriorates its toughness.

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If the crack has occurred from strain in the mouth it will be best to file or sculper away nearly the whole of the lingual surface, leaving just sufficient of the old vulcanite to retain the fit. In such a case it is well to see first that the fit is good, as the accident sometimes happens in consequence of the teeth having nothing underneath to support the masticating pressure from the absorption of the supporting tissues. In this case a refit or a new piece must be made.

The fresh roughly cut surface of vulcanite is to be smeared with the chloroform solution of vulcanite and a sufficient quantity of warm rubber is to be solidly packed upon it; the flask can then be filled with plaster and is ready for cooking.

It has been objected that this plan of packing does not give such solid results as the ordinary method from an idea that the rubber is compressed when the flasks are screwed together. I believe this objection is founded on a misconception of what takes place. When two halves of a flask are pressed together, gates being cut for the escape of superfluous rubber no compression can take place. The rubber is pressed from one place to another; if any empty spaces have been left in packing these may be obliterated and the mass rendered homogeneous. Hence, in packing by the new method, we must take special care to pack solidly. The resulting rubber is then as strong and solid in every respect as if previously pressed.

One point must be insisted on. When old rubber is being joined to new the workman's hands must be clean. Before finishing roughing the surface of the old piece he should wrap the flask or model the work is on, all but the part he is working, in paper; he should then wash his hands and roughen the surface all over afresh with sculper and clean rough file, taking care that no smear of plaster is brought over any part by the tool. Having a perfectly clean virgin surface it is to be coated with the chloroform solution, after which a slight soil is of less consequence. If this

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point has been attended to, although there will be a difference in colour between the old and new, there will not be the slightest appearance of joint or weakness.

In adding isolated teeth to a vulcanite piece the impression should be taken as described in my last chapter for gold work with the piece in the mouth. The plaster model being poured with it in the impression, remove the piece from the plaster model, breaking or cutting the plaster away freely except just where the addition has to be made, rough file the vulcanite around the place where the added tooth is to go, and cut a dove tail if necessary, as in the ordinary method by wax. Having chosen and fitted the tooth clean file the vulcanite and apply the chloroform solution. Then pack rather too much fresh vulcanite to allow for some being squeezed out when putting the tooth in place. Press the tooth into the rubber, and if there is too much, remove some with a hot instrument until it will nearly go down. The pins of the tooth are either bent or have heads; in either case if pressed straight into the vulcanite it might not close around them sufficiently to give a secure hold; therefore take a very thin strip of rubber and wind it in a figure of eight around the pins before placing the tooth for the last time.

When this is done the vulcanite round the pins will stick to the vulcanite in the gap, but you cannot force the tooth down properly as it will crawl back again. To overcome this difficulty the tooth must be heated by holding the model so that a point of the tooth just touches the blue part of the gas flame. When the tooth is quite hot take hold of it with a napkin and press it forcibly into its place. Whilst still holding it there press the vulcanite which has been displaced firmly towards it. It will not now rise again, and is ready to be flasked and cooked. No doubt this method of doing repairs was the stepping-stone to Mr. Williams' advance of packing an entire piece in that manner. I read a description of it in the 'British Journal of Dental Science' six or eight years ago when I had been in the habit of doing

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repairs so for two or three years, but I do not remember the name of the author of the paper.

When a lower piece has to be raised and refitted if there are any natural front teeth standing this makes the bar behind these incommodiously thick. If there is a strengthener this cannot be reduced by filing. It is best, therefore, to cut the bar away altogether and use the back teeth again in block.

Mr. B. had been wearing a set consisting of a gold upper supported with springs by a vulcanite lower, which latter supplied the molars, second bicuspids, and central incisors. The ridge of the jaw had now receded so as to allow a space of nearly the eighth of an inch between the grinding surfaces of the upper and lower molars. He had also lost the lateral incisors.

A model and correct bite having been obtained in the ordinary manner it was determined from the great length of the remaining canines and bicuspids, and the depth of the space required to be filled to make up the bite, to pack the piece on the model, and use the side blocks again.

Although by this method of packing the difficulty of making an accurate fit to the model is overcome it is by no means as easy to arrange teeth correctly to the bite in vulcanite as wax. This is much more easily done when the teeth are already blocked than when they are separate. It is sometimes necessary to block them as a preliminary step, as I have described in a future chapter. In the present case having the blocks containing the teeth fitted to the bite and the swivels ready to our hands it is a manifest advantage to use them. They will also prevent any tendency to sponginess, which sometimes occurs in very thick pieces. The old gold strengthener was therefore taken out to be reused, a fresh fit was packed in new rubber in which the incisors were placed as previously described; but before putting up the side blocks they were reduced by filing away the lingual surface, and the labial surface below the swivels in two planes inclined towards the centre of the basal

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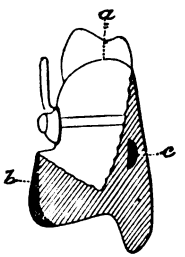
surface until they met, so as to give every facility for packing the fresh rubber, at the same time allowing the old to be nearly covered by it (see Fig. 14).

FIG. 14.



Section of new piece through the swivels. *a*. Old vulcanite carrying teeth and swivels. *b*. New vulcanite. *c*. Gold strengthener.

The old strengthener being packed in again and the piece completed it answered very well.

It is so easy to make an addition to an old piece without disturbing its fit, by packing vulcanite on it on the model, that this is often the most advantageous method of dealing with gold pieces. But when so done the gold part must be good strong work, not likely to need future repair, as it rarely happens that any satisfactory soldering can be done subsequently to the addition of the vulcanite.

There is very little cohesive power between gold and rubber; therefore we must depend upon a mechanical form of attachment to hold them together.

We can allow the gold to enter the vulcanite and be grasped by it; or, *vice versâ*, the vulcanite to enter the gold.

In each case the following points must be attended to:

Gold is incomparably stronger than vulcanite; therefore the attachments of gold which enter vulcanite must be much smaller in bulk than the vulcanite which holds it, and must enter it for some distance, or it will be liable to be broken out. Wire is generally the best form for such attachments. Short pieces of gold wire having their ends

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flattened by a blow of the hammer are convenient. They can be bent into loops, the flattened ends being soldered to the plate, or, one end being soldered to the plate, the other flattened end may have a hole punched in it. (See Figs. 15 and 16, *bb*.)

On the other hand when the vulcanite enters the gold its substance must be greater than that of the gold surrounding it; and as there is never the same thickness of gold as may be had in vulcanite, this method is only adopted where the latter substance may be allowed to overlap the gold plate for some distance. In this case holes larger in diameter than the intervening plate should be made along the edge to

FIG. 15.

a. Gold plate. *b b*. Wire loops flattened at the ends and soldered to the plate. *c c*. Wire stays flattened at the ends and soldered to the plate and bands. The dotted lines enclose the parts covered by the vulcanite and teeth.

be overlapped, and these should be countersunk on the side opposite to that about to be covered with rubber. (See Figs. 16 and 17).

In each case of attachment each material passes into or overlaps the other, and there are two points where this overlapping ceases. These points require attention.

Where the gold leaves the vulcanite will be the point of deepest attachment of the vulcanite, and escape of the gold; and where the vulcanite leaves the gold will be that of deepest attachment of the gold and escape of the vulcanite.

The gold at its point of deepest attachment will have no

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transverse breaking strain, but will only have to resist a drawing strain. It, therefore, may be very slight; if wire, it may be flattened and an eye punched through. But as it gets nearer its point of escape it must get stiffer and the points of escape both of gold and vulcanite should be as strong as the rest of the plate, or fracture may be sooner or later expected.

The same principle applies to vulcanite where it overlies a gold plate. Its strongest attachments must be close to its point of escape: its deepest attachments being graduated to support the gold plate, which has been weakened at the edge by the large holes made, and also to prevent its edge, where it lies flush with the upper surface of the gold, from being chaffed up by wear. (See Figs. 16 and 17 *c c c*.)

FIG. 16.

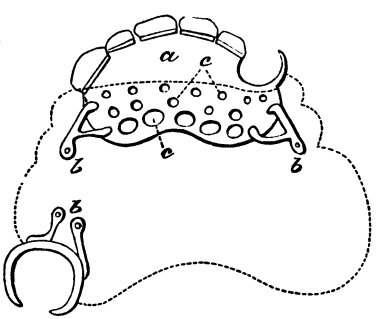

FIG. 17.

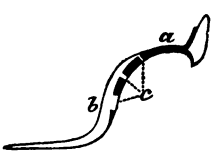

FIG. 16.—*a*. Gold plate carrying five teeth. *b b b*. Wire stays soldered to plate and clasp, having their ends flattened and holes punched at the points of deepest attachment for better hold in the vulcanite. *c c*. Holes in the plate to give attachment to the rubber. The dotted line encloses the space covered by the vulcanite and teeth of addition.

FIG. 17.—Medial section of Fig. 16. *a*. Gold plate. *b*. Vulcanite ditto. *c*. Holes through the gold filled by vulcanite to show counter-sinking from the under side.

Mr. B— had worn for many years a nicely fitting gold upper supplying the bicuspids of both sides, as well as the first molar of the right side. The stumps of these teeth had

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been allowed to remain by the maker of the piece; but these had become loose and troublesome, and were consequently removed.

The subsequent absorption having ceased he wished to have a new piece; but the palatal portion of the plate fitted so well that it was determined to add teeth and fresh base over the alveolar ridge with vulcanite.

The gold covering the alveolar ridge and carrying the teeth was sawn off, leaving on the band around the left molar; the right one, being imperfect, was removed.

The plate in this state was placed in the mouth, and an impression taken which brought away the plate in it. Into this, plaster was poured, producing a model with a correct impression of the alveolar ridge with the palatal portion of the gold plate in its right position relatively to it.

A loop of gold wire was soldered on at each side so as to take hold in the mass of vulcanite under the teeth. A new band having been fitted around the right molar, wire stays were soldered from the plate to the bands. (See Fig. 15.)

The plate was then placed on the model and teeth arranged to the bite; vulcanite was then packed on the alveolar ridge and around the attachments. The teeth were then set as described at page 27, and the piece vulcanised. When finished it answered very well.

Mr. W— had a small upper gold plate carrying four flat back incisors with clasps around the canines. The crown of the right canine having given way the piece would not keep up. A flat back tooth was added to the plate with a pivot running up into the root of the canine; but this did not answer.

There were no back teeth on the left side, and none until the second molar on the right. The gold was stout, the backs of the teeth short and strong, so that in case of accident a tooth could be replaced by rivetting, and the piece looked well.

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It was therefore concluded to fill up the vacancies in his mouth by adding teeth in vulcanite. Thus giving him a piece more comfortable than a new vulcanite piece at half the expense.

More comfortable than a new vulcanite piece, because thinner behind the front teeth where the tip of the tongue lies. This being one of the parts of the mouth where a thick plate is particularly obnoxious to the patient.

An impression was taken with the plate in the mouth, and the model poured as in the previous case.

Wire attachments were soldered to the plate so as to enter the vulcanite over the alveolar ridge. (See Fig. 16 *b b*).

Holes were made in the plate, Figs 16 and 17 *c c*, as previously described. A band was bent around the molar, and attachments soldered to it as figured Fig. 16.

The teeth after having been fitted to the bite were set as in the previous case. Vulcanite having been packed over the part indicated by the dotted line Fig. 16. The piece was vulcanised and finished, when it answered satisfactorily.

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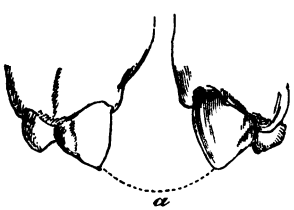
CHAPTER III.

ON VULCANITE DENTURES.

Miss H—, aged about fifteen, had fissure of both hard and soft palate. The fissure passed in a nearly central position between the intermaxillary bones, and the central incisors had never made any appearance. The laterals had been extracted in consequence of malposition. The canines approximated, as shown fig. 18 *a*, and together with the left bicuspid closed within the lower teeth.

Fig. 18.



Drawing, natural size, to show space between canines before regulating of Miss H—'s mouth.

Mr. Smith, of London, performed a very successful operation, closing the fissure in the soft and nearly all the hard palate, leaving a gap between the canines which passed into the nasal cavity.

In early life there had been an operation for harelip, leaving the upper lip deficient in substance and flat looking, which made it particularly advisable to expand the arch of the upper teeth so as to give as much fulness as possible to the contour there.

A vulcanite piece carrying two central incisors was

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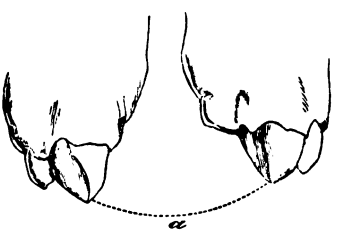
made by packing on the model. This was made to act as a regulating frame at the same time. Wedges of compressed wood were driven in between the centrals and the natural canines, when the piece was in place, until a little space was gained, when square-headed pegs of the same material were substituted. At the same time a chamber for the purpose having been formed inside the left bicuspid a piece of compressed wood was placed there which gradually pressed it into the desired position. In about six weeks the three teeth were driven outside the bite of the lower teeth, and the space between the canines had been increased to that in fig. 19 *a*, which was considered sufficient.

FIG. 19.



Drawing, natural size, to show space gained in Miss H—'s mouth. Compare with Fig. 18.

A piece for permanent wear was proceeded with in the following manner:—The four incisors used were vulcanite teeth with porcelain gums. These were fitted on a wax base on the model. This was then tried in the mouth and such alterations made to suit the bite and expression as were necessary. It was very desirable, from the depth and shape of the cleft, to pack the piece on the model, which was done in this way.

The wax trial-plate and teeth were replaced on the model. Looking at it in front, teeth uppermost, the crowns of the mineral teeth were highest in the gap, then the mineral gum, and below this, filling up the gap between the oral and nasal

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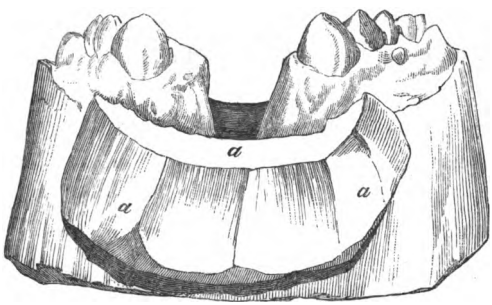
cavities, half an inch in depth of wax. Holes and notches were scored in the model around the border of the visible wax, so as to hold fresh plaster. A batter of this, half an inch in thickness, was then poured on so as to cover the wax in front up to the bottom edge of the mineral teeth; here it was left thick and extending half an inch on to the scored surface of the model. (See Fig. 20 *a, a, a.*) In the drawing the teeth and wax have been removed.

FIG. 20.



Method of packing a difficult case on the original model without pressure. The cap, Fig. 21, fits on above *a*.

When set the plaster was smoothly trimmed and a fresh batter of plaster of similar thickness was poured, so as to cover the whole of the visible portions of the mineral teeth and gums, and brought down flush with the edge of the previous batter and over the faces of the plaster canines. When this was sufficiently set all the wax of the trial plate was removed and washed out with boiling water. The cap of plaster containing the mineral incisors was now readily removed. (See Fig. 21.) The wall formed by the first batter of plaster remaining in place, as in Fig. 20.

The whole of the plate was now packed with rubber; it extended back as far as the soft palate, and supplied a deficiency caused by the loss of a molar on the left side. A small piece of pumice stone was packed into the fissure for the sake of preventing the thickness of this part making the

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piece heavy. The vulcanite was packed up to a level with the edge of the wall *a*, Fig. 20. Then the plaster block containing the teeth (Fig. 21) was replaced on the model in its

FIG. 21.

Plaster cap, containing mineral blocks fitting on Fig. 20, to be tied on before the piece is finished packing.

original position, and firmly tied there with twine, whilst more vulcanite was packed around the pins and behind the teeth. The whole was then invested with plaster, flasked, and vulcanised. It has answered very well.

Every vulcanite piece should have a metallic strengthener, unless we except small pieces of two or three teeth in juxtaposition on one side of the mouth, which are sometimes required to supply a deficiency of natural masticators.

Platina or gold answers almost equally well for this purpose; but as, for reasons to be presently mentioned, it is best to have the metal exposed on the lingual surface of the plate, and gold looks best, at any rate in the eyes of the patient, and the conveniences for using it are always at hand in the workroom, this will probably be the chosen material.

In putting metallic strengtheners into vulcanite plates it must be borne in mind that there is very little adhesion between the two materials; so that when two layers of the latter have a layer of metal between them, they are divided and their strength impaired as far as breaking strain is concerned. To give the greatest strength to the piece, therefore, with the least substance, all the metal which is to give strength to the piece should be on one surface, with

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only so much metal entering the rubber as will firmly attach the two materials together.

It should be a rule, with few exceptions, that the whole of the surface of the piece fitting the mouth should be of one material. If gold be used for the fit the piece will rank as a gold plate having the teeth mounted on rubber; if the fit is in vulcanite, the gold should be on the lingual surface.

Lower pieces carrying the masticating teeth with a bar passing behind the incisors are sometimes made with this bar entirely of swaged gold which passes into the vulcanite at the sides. When this is done two stout gold wire fastenings must pass from each end of the gold plate into the vulcanite, so as to give a firm attachment between the two, as shown in fig. 16 *bb*, only that the wire must be stouter than there figured. Pin wire for tube teeth is about the size.

In packing the rubber the flask must not be opened and closed so as to press it in the ordinary method, as this would probably disturb the gold from its position, raise it by a little of the rubber creeping under or the pressure of the inclosed vulcanite may prevent the gold being brought perfectly close to the model.

The plaster cast, with the wax model and teeth upon it, is to be set in the lower part of the flask, in plaster, which is to be brought up at the sides so as to cover and hold the teeth, leaving uncovered only the lingual surface of the wax. When set the plaster must be trimmed so that the upper part of the flask will easily separate from it; this is now put on and filled up with plaster. When set the flask is to be opened and all the wax removed by boiling water; the rubber can now be packed and the flask pressed together without moving the gold from its position. Special flasks for packing in this way are sold, but I have not found them very advantageous.

Pieces should, however, seldom be made having the surface which is to fit in two parts separately adapted, as the difficulties of giving both an equal bearing greatly overbalance any real good to be obtained. Such pieces please the eye of

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workman and patient, as they are capable of showing more value in work and finish, but the only real advantage which they can lay any claim to is that less space is occupied under the tip of the tongue. If there is very little depth of hard gum between the necks of the lower teeth and the loose movable mucous membrane covering the frænum, so that the bar here has to be unusually narrow, or when a patient has an intolerable aversion to any thickness at this part, a piece made as above described may be indicated.

In most lower pieces a wire may be used, bent so that the upper surface shall show on the lingual surface of the piece opposite the necks of the patients' teeth, dipping into the vulcanite on each side for its own attachment at the point between the second bicuspid and the first molar, or any place which the construction of the piece makes most convenient. A stout half round gold wire, No. 24, Stubb's plate gauge, is very useful, taking little room and being sufficiently strong. It is bent in the following manner: if the front teeth in the mouth are vertical in position the middle of the wire which lies opposite to them only requires to be bent in a suitable curve with its plane side towards them; but if, as is usual, the teeth slope more or less forward the wire cannot be bent in this manner, or its longest diameter would have a proportionate inclination towards them which would either cut the vulcanite in two or necessitate a clumsy thickness to the plate; therefore, before bending it on its short diameter, *or flat,* the wire must be first bent on its long diameter, *or edge,* the curve being little or much in proportion to the slope of the patient's teeth (see Fig. 22 *d*). The wire can readily be bent if grasped by a pair of pliers having two transverse notches exactly opposite each other filed across the face of each blade. The two ends of the wire which are to enter into the vulcanite will require each three bends at right angles, and as one of these bends is on the edge of the wire it will be best to do it at the same time that the middle part of the wire is bent on the edge (see Fig. 22 *b*).

In order to finish the bending of the ends each must now

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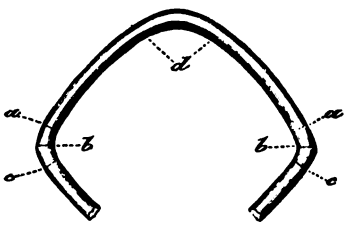
have two more bends on the flat at right angles, one at *a*, Fig. 22, having the flat on the inside of the bend, and one at *c*,

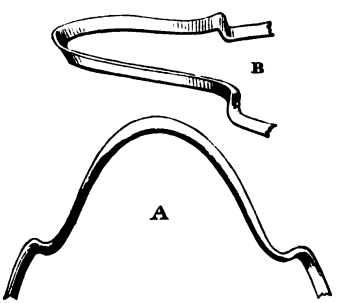
FIG. 22.



Half-round wire for lower strengthener. First stage, bent on the edge.

having it on the outside. The middle of the wire is now bent on the flat, the flat side being on the outside of the bend, so as to suit the curve of the teeth on the model, when it will be found that the inner surface of the wire can readily be

FIG. 23.



Same as Fig. 22, finished. Drawn in two positions.

kept parallel to their inclination. Fig. 23 A, B gives two positions of the wire as bent when finished.

Vulcanite upper pieces, from the masticating strain, generally break between two of the front eight teeth, therefore we shall have a sufficiently large strengthener if we carry it back on each side so that the ends terminate opposite the first molars. A swaged plate should be used, the anterior

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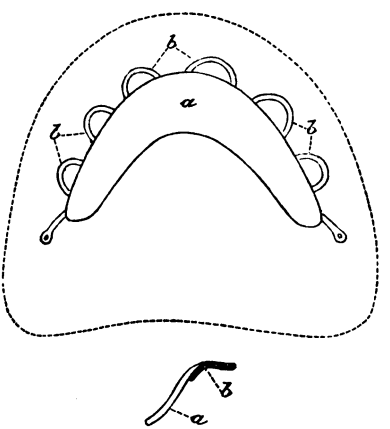
edge of which should terminate where the vulcanite begins to thicken as it rises to support the teeth. In this thickened part the attachment-pins of the gold should lie. The depth of the plate should be proportioned to the strain which the habits of the patient lead us to anticipate, but as no delicacy of fit is required a narrow stout plate is preferable to a deep thin one. If the palate is tolerably flat the plate may be swaged upon dies cast from the original model, but if the palate is a deep one it must first be covered on the model with a layer of wax of equal thickness with the rubber which is about to be used before dies are made from it; as the discrepancies between the upper and the under surfaces of a

FIG. 24.



a. Gold strengthener, No. 8 or 9 thickness. *b b b*. Wire staples soldered on the lower side of plate as shown in section below. The dotted line represents the external margin of the piece.

layer of even thickness placed on a model are greatly increased in proportion to the depth of the curves passed over. Fine wire staples, having their ends a little flattened for convenience, should be soldered along the anterior edge of the plate, so as to pass into the thick mass of rubber lying underneath the teeth (see Fig. 24 *b, b*).

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Vulcanite presents so many advantages for lower cases that it is almost universally used for this purpose in preference to any other material.

That part of the lower jaw which has to support the pressure of the plate is formed of the whole or parts of a curved ridge of nearly equal width, occupying a position below that from which the crowns of the natural teeth have been removed. The sides of this ridge, if the fangs of the teeth have also been removed and time elapsed sufficient for the absorption of the alveolar process, slope outwardly towards the lips and cheeks, inwardly towards the roots of the tongue, and downwards generally on both out and insides. The inclination of these sides to each other differs much in different individuals, varying from a good supporting surface nearly as round and broad as the back of a man's forefinger, to a thin ridge, presenting almost an edge, the base of which does not widen to more than a quarter of an inch before it is lost in the soft moveable lingual or buccal tissues, which are unavailable as a supporting base. Lower cases, therefore, have always much less supporting surface than upper ones where the same deficiency has to be filled with substitutes for the natural teeth, and they labour under the further disadvantage, as compared with uppers, that in addition to the force of mastication their own weight adds to the pressure.

The deficiency of supporting surface added to the more or less sloping position of the sides of the ridge gives the piece a tendency to sink a little after being a short time worn, and this sinking allows the edges to cut the mucous membrane, often producing ulcers or sores. Added to this inconvenience the moveable soft tissues, notably the frænum, often encroach further than has been anticipated, and the piece presses upon them unduly and in a manner which they will not tolerate. From these reasons it often happens that lower dentures have to be considerably eased by filing after they have been a short time worn, and it is always desirable to have thick round edges.

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Almost the whole of a lower set lies beneath the free margin of the tongue where bulk is much less obnoxious to this organ than it is above; hence the advantage in point of thickness which a gold piece can claim over a vulcanite one is so much more than compensated for by the difference in the ease with which a comfortable fit is made, that on the true issues of the case I think vulcanite will generally be preferred.

Small lower pieces to replace several teeth, the blank spaces being separated by still remaining natural teeth, will be most advantageously made by being packed in rubber directly on the original model. In working in this way the difficulty lies always with the bite; and in such pieces, the natural teeth still remaining, generally readily and correctly indicate the bite with upper teeth, and when there are not more three or four teeth to be placed side by side in the rubber it is tolerably easy to get them in position.

Such cases of which the models represented several isolated natural teeth were particularly difficult to fit accurately when made by using first a wax piece, and then pressing rubber into the space occupied by the wax, after its removal, between the two halves of a flask; as under the best circumstances the plaster teeth were very apt to break on separating the halves of the flask to see if the right amount of rubber had been packed in, and the fit of the piece was thereby impaired.

Lower pieces carrying the molars and bicuspids, connected from side to side by a bar passing behind the front teeth, are generally kept in place by springs connected to an upper piece, or by clasps embracing the two posterior natural teeth, one on each side. In either case, after a little experience the piece may be packed at once on the models as the previous cases. A skeleton wax piece should be used in the first place, so as to get the strengthener and bands or swivels correctly adjusted, and the teeth let down to the bite before beginning to mount them in rubber.

The next class of cases, where the front teeth are gone as

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well as the molars, leaving the canines and one or two bicuspids on each side, may also I think, with care, be packed at once in rubber; but when we come to mouths in which the lower jaw has but three teeth or less, or if, for special reasons, it is necessary to try the piece in the mouth first, it will be best to model it in wax first and pack in rubber after a matrix has been made in the ordinary way. Instead of setting this wax piece on the original model in the lower part of the flask, I think it is safer, avoiding the risk of accident, to use a tin cast. If there are any teeth standing on the model, these should be cut short before casting, or they may be filed short on the tin cast after it is poured. A parting must be used of tissue paper or book-binder's gold leaf; when very little difficulty will be found in separating the cooked piece from the model.

There are exceptional cases in which the advantages of packing on the model are so great as to compensate for the extra time and trouble of twice vulcanising; overcoming the difficulty of the bite the first time, and of fit the second. The following cases will illustrate this:

Mrs. H— required a set, the upper to be kept up by springs, the lower jaw presenting the following conditions:— The second bicuspid and second molar remained on the left side, with about the width of a small bicuspid between them, giving room for the attachment of the swivel for the spring on that side; on the other side, the canine, first bicuspid, and first molar remained, the gap caused by the absence of the second bicuspid giving a similar convenience for the insertion of the swivel as was found on the other side. From a peculiarity in the bite of the upper teeth, of which some of the front natural ones remained, it was necessary to adjust a wax trial plate to the mouth in order to get a pleasing arrangement of the front teeth. In consequence of the isolated position and length of the natural teeth, this case would have presented some difficulty if made in the ordinary way, and it would have been almost impossible to have

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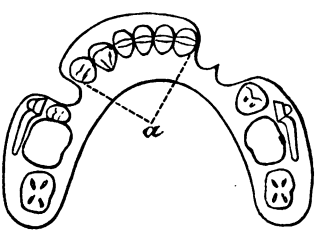
separated the parts of the flask after having pressed them together, if a plaster model were used; a perfect tin would have been difficult to cast, and still more difficult to remove from the vulcanised piece. It was therefore determined to pack it upon the model, which was done in the following manner.

A correct bite having been made with the trial plate on the model to be vulcanised upon, that part of the wax containing the incisors, left canine, and bicuspid (see fig. 25 *a*),

FIG. 25.



Lower piece, difficult to make by packing on the model or in the the ordinary way. Made by packing on the model after first making the front teeth into a block by the wax method.

was separated from the rest of the piece, and after reducing the size by paring away the wax on the outer and insides, made into a vulcanite block by itself; by sinking the teeth and upper surface of the wax in plaster in one half of a flask, and when set filling up the other half, so as to take the basal surface, separating the two parts of the flask, removing the wax and packing in the ordinary way. The block, after being lightly vulcanised, was roughly filed so as to leave only just enough rubber to hold the teeth together with light handling, taking care to cut it well away around the exposed margins of the teeth, so that fresh rubber could be easily packed to cover it entirely, and the basal surface reduced to a linear series of points, which enabled the block to be easily set in position on a thin layer of rubber on the model.

The part of model which it was intended to cover was then

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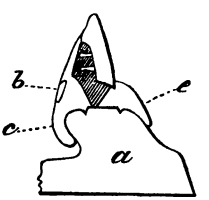
brushed over with the chloroform solution, and a layer of one thickness of vulcanite packed upon it. The rubber surface of the block, which was clean-rough filed, being also smeared with the solution, the block was adjusted to its position on the model by the bite. In doing this no difficulty was experienced; the remaining requisite quantity of rubber was then packed together with strengtheners, swivels, and solitary teeth on to the model, and the piece completed.

Mr. H— had a very peculiar mouth. A gold upper was made which kept up very well without springs; it was therefore desirable if possible to make a lower piece which could also be so worn. The only teeth remaining were a molar

FIG. 26.



Section between the incisors of Mr. H—'s piece on the model.
a. Model, showing undercut. *b*. Gold strengthener. *cc*. Rubber of second cooking; shaded part, rubber of first cooking.

and bicuspid on the left side, having a small space between them. There were several fangs of teeth remaining, both in front and at the sides, and as these were healthy and it was known from experience that they were very firm and unusually long, it was determined to allow them to remain, merely reducing them all to a level surface with the file. The peculiarity of the mouth consisted in the great extent of the undercut of the ridge; the natural teeth when standing having had a considerable inclination backwards towards the centre of the mouth.

In consequence of this undercut, see Fig. 26 *a*, it would have been a matter of no small difficulty to have made a good fit in the ordinary way; and it was necessary, from

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peculiarities of expression, to try the teeth first in the mouth. The same method was therefore pursued as that described in the previous case. A block was made containing all the teeth inclusive from the first bicuspid on the left side to the second molar on the right. A gold band was fitted around the natural bicuspid; this was soldered to the strengthener, packed in the vulcanite together with the block, and the piece completed.

Whenever stumps have to be covered by a plate, packing on the model has many advantages. The usual way is very apt to abrade the sharp edges of the stumps; and although this may be remedied by filing the stump or sculpering away the vulcanite, the result is not so satisfactory as an exact fit; a little space is often left into which gum grows and becomes a source of irritation.

The perfection of fit which this method offers also allows us sometimes to meet the wishes of a patient who manifests an uncontrollable aversion to forceps or elevator.

Mr. B— wore a small gold piece supplying the right upper lateral and a bicuspid on either side. He had lost all the upper back teeth, and having a good set of lower teeth wished for some upper molars to meet them. The stumps of the first molars, however, which still remained, proved an obstacle; they were ragged and nearly half protruded from their sockets. Of course, it was determined to remove them; but appointments made for this purpose were avoided, and the matter shelved from year to year in hopes that the stumps would get loose and come out; unfortunately, they remained in the same condition. At last a model was taken and a vulcanite piece packed over them. This went into the mouth, fitting the stumps without any adjustment, and is perfectly comfortable.

In determining of any particular denture for the upper jaw, whether the fit should be made of gold or vulcanised rubber, the amount of the fee to be received for the work done comes so largely into the consideration, that it is almost

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impossible to enter upon the subject without saying something upon this head.

Very opposite views are held. One professional friend whom I asked what difference he made in his fees between gold and vulcanite work, replied, "Very little; I do not charge for the material of my work, any more than an artist does when he sells a picture; my fee is for my taste in suiting the expression of the countenance, and skill in overcoming the engineering difficulties which are met with in attaining the desired end." Another friend, when asked the same question, replied, "I do not put out much vulcanite work; most of my lowers even I make in gold: my patients do not mind what they pay for good work, and I can get a fee for a gold piece which no one would give for vulcanite." Harris says nearly the same at p. 737: "As a rule patients will pay best for art when exercised on an expensive material."

Neither of these views seem to me quite sound. There is a large class of cases in which either material will make an equally successful and comfortable denture. In this class I think the choice should fairly have reference to the fee to be charged; for the wealthy patient using gold, for him who has to be careful of expenditure vulcanite. But there are many cases where dentures are required for the upper jaw in which a gold plate is distinctly indicated: on the other hand many, where vulcanite will give an evident advantage; and between these two classes many, in which a good deal of judgment will be required to choose the best material.

Whilst fully agreeing with the opinion first quoted, that it is our taste, knowledge, and skill which are paid for, and that the difficulties which we are called on to surmount give the profession its position; I still think that this skill and taste will be all the more valuable and valued if directed by a judgment unbiassed by the consideration of the amount to be received for the work done; and that the best way to attain this end will be by making such a difference in

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charge between the two styles of work as shall make it of no consequence to the dentist, in a monetary point of view, which material is used. When the difference is only in material and labour, there need only be a sufficient allowance made to cover the difference in the cost of these two articles. But wherever a real difficulty in dental engineering is surmounted more easily by vulcanite than gold, there ought to, and will inevitably in the long run, be a considerable diminution in the fee charged; for a comfortable denture is too valuable to the community to maintain an artificial price.

Artificial sets of teeth for edentulous mouths are usually arranged to maintain their proper positions by springs. Harris, indeed, says, "Spiral springs formerly very much used are now seldom employed;" and Oakley Coles, in his handbook: "A large number of practitioners have dispensed with their application to sets altogether." I think, however, that these expressions of opinion are rather sanguine, and that the excellency of work which is required by the practice, has led these practitioners to undertake a difficulty uncalled for by a sufficient gain to their patients of comfort or convenience.

It is generally easy to make a suction piece for an entire upper set, but to keep a complete lower denture steady at the same time multiplies the difficulty manifold; a slight shifting of the lower gives an uneven and unexpected bite, and the patient is liable to the mortification of finding both pieces hopelessly adrift in his or her mouth on most inopportune occasions.

Absorption of the alveolar ridge continues for years in some mouths, and many a set which is worn with comfort and confidence with springs, would, from this cause, have become entirely useless if made without, however perfect the suction might have been when first put into the mouth.

On the other hand, springs are not generally much inconvenience to the patient, but are felt to be reliable safeguards, in which great confidence is placed, so that however much

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we may admire the work of him who never uses springs for full sets, I think we shall find it safer practice to make their absence the exception rather than the rule.

That this is the general opinion of the profession is evidenced by the fact that the depôts maintain their sale of springs amongst our best practitioners, and that few complete sets worn without springs come under notice.

The advantage in lightness and adaptability which vulcanite has over gold being obviated when springs are used, and gold having the advantage in strength and absence of bulk. The only question to be considered in choosing the material is one of cost, except in a few exceptional cases in which thickness of substance is an advantage instead of the reverse.

Absorption removes the whole of the alveolar ridge in some upper jaws which have been edentulous a long time, leaving a flat platform with a nearly semicircular margin, having a slight depression between this and the buccal and labial adhesions.

In these cases, or such as approach them in character, the loss of substance, which it is well to restore to the patient, will have a much wider base than the teeth to be mounted, and if this restoration be made with vulcanite I can conceive of no advantage to be gained by putting a gold plate between it and the sustaining mucous membrane. The following case will illustrate what is meant.

Mrs. F— consulted me about a difficulty which she experienced in talking or reading aloud, with a set of teeth she was wearing. To do either fatigued her much, and some particular sounds, as far as memory serves me, th, ch, and sh could not be articulated at all. The mouth was one of those flat ones just described. The set was made of 20-carat gold plate, No. 9 thickness, with exceedingly long tube teeth standing nearly perpendicular to its surface.

Mrs. F—, who was elderly, and had been without natural teeth many years, produced for comparison a much older

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set, with which she could speak perfectly, but which required a large wad of cotton wool to be placed between the plate and the gum to enable it to be worn. On looking at the two sets side by side the reason of the defect suggested itself. The older of the two sets, having been made before the absorption of the alveolar ridge, still gave the oral cavity the required form for speech. As a tentative measure, the lost contour of the palate inside the teeth of the new set, was restored with Truman's gutta percha. This at once remedied the defect; an appointment was made for the application of a more permanent material, but the gutta percha answered so well that it was worn for nearly seven years, when the set having fallen into disrepair she had a new one, in which both upper and lower pieces were made in vulcanite.

With the exception of such cases I think a metal base preferable for all upper pieces which are kept up by springs; but where the presence of natural teeth in the lower jaw gives dependable steadiness to the denture it supports, an upper piece in vulcanite can often, in consequence of its lightness and fit, be kept up with more comfort to the patient.

Mrs. B— had worn a vulcanite piece supplying the loss of all the upper teeth except the wisdoms and centrals; these becoming loose were extracted and substitutes added to the plate in the usual method of repairing such deficiencies, and the piece worn, not very successfully, as a suction piece for some months to allow the usual recession of the parts from which the last teeth had been extracted.

The piece was then reset on a fresh model; but the success was not great, and the patient was very desirous of having springs. The lower piece which she wore was one, however, to which springs could not easily be added, in consequence of the position of some of the natural teeth, and it was therefore determined to make another effort by making a new piece to maintain the upper in its position by suction.

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To do this required some nicety in arranging the bite. The lower teeth projected considerably, and it was necessary to reduce the projection of the upper teeth as much as possible, making an edge to edge bite to prevent the denture being pulled down—by the upper lip when the patient opened her mouth—a misfortune which the old piece was liable to.

Being anxious to give the delicate fit to be obtained by packing on the model, the piece was made in two vulcanisings, by the method described in my last chapter, but which it may be as well to explain more fully in its application to upper dentures.

A wax base plate was adjusted on the model as for ordinary work, the gold strengthener, previously made, was placed in it to keep the wax from bending whilst being put in and out of the mouth. The two central teeth were then placed upon the wax approximately, tried in the mouth and adjusted, then the lateral and the rest of the teeth two at a time.

Where there is a difficult front bite, and appearance is a matter of importance, the method of arranging the teeth to the mouth in this way will not I believe be found any loss of time or trouble in the end; it overcomes the difficulty with certainty at that period in the construction of a set when alterations are most easily made. It may not be always necessary, yet I am convinced that no other method of suiting the teeth to the patient's physiognomy is to be compared with it. This method is also the best way of getting the bite where there is not sufficient masticating power, and the articulation between the teeth of upper and lower sets requires particular attention.

All the upper teeth having been arranged on the wax plate in the mouth, the piece was placed on the plaster model and an accurate bite made with a model which had been previously taken of the lower natural and artificial teeth together. The wax upper piece was then removed from the model, plaster poured into the under surface and set with the teeth uppermost in the lower half of a flask.

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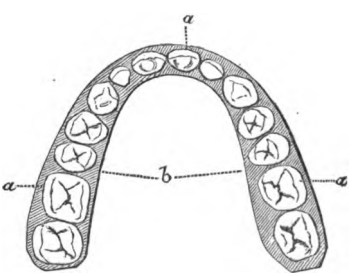
When the plaster was set the whole of the palatal portion of wax, together with the strengthener, was removed, leaving teeth and wax as in Fig. 27.

The upper part of the flask was then put on filled up with plaster, and when this was set the flask reopened and the wax washed out with boiling water. Rubber was then packed in the ordinary way, the flask pressed and screwed together and the piece vulcanised. This produced a piece fitting the model with the teeth in right position and bite, but mounted on a narrow rim of vulcanite, Fig. 27.

The rubber was then roughly filed outside and inside the teeth in two planes which met in a line on the basal surface directly under the teeth, so that its section would appear like *b*, Fig. 29. This line was then reduced, by rough angular cross cuts, into points. Thus we had the

FIG. 27.



a, a, a. Arranged row of upper teeth, held in position by a narrow ridge (*b*) of wax first, subsequently vulcanite.

teeth held together in their right relative positions by rubber, which, when placed upon the model, indicated by a linear series of points its right place.

The face of the model was now smeared with the solution of rubber, and a piece of thin sheet vulcanite, cut out by pattern to the shape required, was placed upon it and pressed with the fingers until it adhered closely to the whole of the surface which it was desired to cover.

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Complaints have been made to me that the rubber when so put on cannot be got to stick but springs off again. This difficulty will not occur if the chloroform in the solution has been allowed to evaporate, and the rubber is packed hot. A convenient hot bath is made by having a small gas stove on the bench in front of the workman; on which is placed a common saucepan with a clean dinner plate for a cover. Water is boiled in the vessel, and the vulcanite cut in convenient pieces arranged in the plate ready for use.

I prefer Lemale's German rubber for suction uppers; partly because I believe it has not so great a tendency to warp as the light whalebone or bowspring rubbers, if unfortunately it should require a second cooking in consequence of repair or addition being at any future time necessary; but also because it is thinner than any other rubber in the market; which in this method of packing is an advantage.

The pattern of rubber having been stuck in its right position, the vulcanite rim carrying the teeth was placed upon it, and by means of the bite easily adjusted to its right place. The resistance which the soft rubber on the model offered to any slight movement required, having been reduced to a minimum by the hard rubber only resting upon it in a series of points, see Fig. 28.

The freshly filed surface of the vulcanite was now smeared with the rubber solution, and the model with teeth in position placed in the bite. Vulcanite was then packed around the necks of the teeth, and everywhere on the outside to fill up the required contour. Model and piece were then removed from the bite frame, and the strengthener adjusted to its place by being warmed and lightly pressed into the soft vulcanite. Rubber was then packed around the attachment pins of the gold, and to fill up the contour inside to the necks of the teeth. The palatal portion of the rubber plate not covered by gold required another layer of thin rubber to bring it flush with the edge of the metal plate, and give it necessary stiffness; any openings at the

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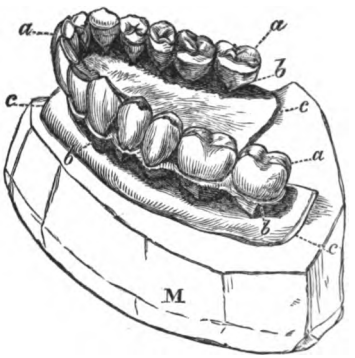
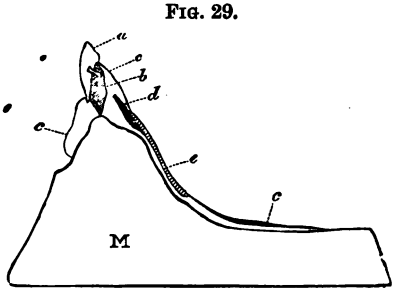
FIG. 28.



To show method of packing suction upper without pressing the model in flasking. *a, a, a.* Teeth held together by *b, b, b,* cooked rubber which has been flasked and pressed. *c, c, c.* First layer of uncooked rubber placed on the model M before *a, b* is placed upon it.

joinings not easily made plaster tight were stopped with wax. The whole was now smothered in plaster, flasked, vulcanised and completed. It answered very well. For section of complete piece see Fig. 29.

FIG. 29.



Section of piece packed on the model. *a.* Tooth. *b.* Rubber of first cooking. *c.* Uncooked rubber. *d.* Wire attachment of gold strengthener. *e.* Gold strengthener.

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CHAPTER IV.

SUCTION UPPERS.

Before going further in description of the construction of suction uppers, it may be as well to consider the general conditions upon which depends the success of the method of keeping up dentures by atmospheric pressure. The air has a pressure of about sixteen pounds to the square inch, and we might infer that, if excluded from between the plate and gum by their continuous contact, the whole of this force would act so as to keep them together; but, as a matter of fact, we know that we rarely approximate this amount of support in practice. Some mouths give very much better results than others, which we can often foretell by merely looking at the shape of the model and the arrangement of the bite. 'Harris's Practice of Dentistry' has some good reflections on this head, which, however, do not seem to me to have quite exhausted the subject. Moisten the palm of the hand and, as a schoolboy would say, suck a thimble on to it; the thimble will adhere firmly in consequence of the air inside, being partially exhausted, not having so much pressure as the external air. If a small coin having the same diameter as the thimble is now moistened and pressed on the skin so as to exclude all the air, it will be found that it does not attach itself to the hand, but falls off by its own weight. A consideration of the difference between the conditions which leads to this difference in result will, I think, throw some light on our subject.

Harris gives as an illustration the fact that if two pieces of polished plate glass are pressed together so as to exclude

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the air, they cannot be readily separated. If we separate the two pieces of glass by force, the glass being a rigid substance, the whole of the surfaces in contact are separated at once; and hence the reason they adhered so well, since there could be no separation until the force used for this purpose was greater than the whole of the atmospheric pressure keeping them together. On the other hand, the coin, being in contact with an uneven soft surface, the slightest force presses one side more than the other, which is thereby slightly raised, allowing the two surfaces to separate gradually.

When two surfaces are separated the amount of resistance caused by atmospheric pressure which is felt is in proportion to the amount of surface separated at once; for half an inch square four pounds, for one inch square sixteen pounds, and so on. But when the surfaces are separated gradually, as in the case of the coin, the amount separated at once being represented by a line only, the resistance is practically nothing. The reason the thimble holds so much more firmly than the coin is because it separates all at once, the margin being held more firmly to the skin than is the case with the coin. All the weight of the air pressing the thimble on to the hand has to be borne by the edge, and as this does not occupy a two hundredth part of the surface covered by the thimble, it follows that there is more than two hundred times as much pressure on the edge of the thimble as on the edge of the coin. This increase of pressure keeps the margin firmly on the skin until by the strain of withdrawal the skin is rendered tense and rigid, and will not allow of a gradual separation.

The advantage, therefore, which a suction chamber gives when it answers is not from any inherent good in a vacuum over an exact fit, but that it puts all the pressure, which belongs to the vaulted surface, on the margin of that space, and thereby gives that margin much greater power to resist gradual separation.

To the use of special chambers constructed in dentures,

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after a dozen trials, I have been steadily opposed, being convinced that where they act the mucous membrane speedily fills them; and whilst according admiration to the ingenuity displayed by the invention of the suction disc, which is right in principle, yet I can only regard it as an improvement which has come too late. So far as my experience goes, every upper which can be kept up by its use can be kept up without it, and as soft rubber from its perishable nature is not admissible for permanent wear in the mouth, if it can possibly be avoided, whenever there is a difficulty in keeping the lower piece steady spiral springs are to be preferred.

The law which we deduce from the foregoing illustrations may be thus stated:—*There will be a self-regulating suction chamber formed wherever the withdrawing force tends to separate part of the plate from the surface of the gum before any of the margin separates.* For directly any vacuum is made an increased pressure is put upon its margin, which necessitates the separation of a considerable surface at once before the piece can be pulled away. This sort of vacuum has the further advantage of being self-acting, using no more atmospheric pressure than is absolutely necessary, which, when the strain is taken off by the closure of the teeth, immediately ceases to act.

The convex shape of most edentulous superior maxillæ presents the conditions for such a suction chamber without doing anything beyond covering as much of it as the patient will bear by an exact fit. Suppose Fig. 30, *a*, to represent the section of a dome exactly fitted and covered by the plate *d*, the surface of the dome itself, being of a soft, elastic, slightly movable tissue, like the mucous membrane of the mouth, with a return at *c* like the cheeks and lips; now, if we raise the plate *d* a little, as in the right-hand figure, it is evident that it will be much further separated from the lower body at *a* than at *b b* or *c c*; and as this surface is a slightly yielding and elastic one, which will follow the withdrawal of the plate a little, it follows that a vacuum will be formed at *a*

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before air has been admitted at the margins. This, as we have seen, will bring greater pressure on the margins, making them tighter and tighter the more the plate is withdrawn, until their utmost stretching limit is reached, when, if the necessary force is used, the whole will give way at once.

FIG. 30.

Diagram to show the principle of suction in a closely fitting plate. *a c*. Section of imaginary circular soft substance, to represent gums and cheeks, showing that when the plate *d* is raised, as in the right-hand figure, the distance is much more at *a* than *b* or *c*.

From this illustration we learn that the softer and more yielding the tissue which the margin of the plate rests upon, the greater will be the retaining suction force, as such a margin will follow the withdrawal of the plate to a greater distance, and allow a vacuum of greater surface to be formed before it will admit any air between it and the plate.

The best suction cases, as far as resistance to a downward pull is concerned, are those where the external margin is deep and the buccal edge of the plate is thick and smoothly rounded, so that the soft tissues of the cheeks and lips may closely fit and follow it on attempted withdrawal. For the same reason the posterior edge should reach back to and snugly fit the anterior edge of the soft palate. In such a piece we shall have a superabundance of retaining power.

Suction pieces may be classified under two heads—those in which the whole of the alveolar ridge can be covered by the supporting plate, and those in which the teeth have to be set to the gums in consequence of the prominence of the ridge or the shortness of the upper lip. Those classified under the first head, namely, when the whole of the gums

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are allowed to be covered by the plate, are liable to three distinct difficulties:

First, if the alveolar ridge is so small that the teeth have to be set considerably outside the ridge in order to meet the lower teeth, this gives a greater or less tendency to tilt the teeth in mastication.

The second is, when the front teeth are rather projecting, with a thick and muscular upper lip, a tendency whenever the patient laughs for the lip to pull the piece backwards and downwards.

The third difficulty of importance is, when depth of plate at the back of the mouth produces intolerable nausea and only a narrow plate can be worn.

The two first difficulties can generally be surmounted if the palate can be well covered, but a combination of all three will, I think, render the case hopeless, and it will be best to adapt springs to it. In the second class of suction plates, where the teeth have to show, fitting on the natural gums, we are not much troubled with the three difficulties enumerated as belonging to the first class; the alveolar ridge is usually round and full, so that the bite is well supported, and as there is also a good-sized oral cavity, or for some other reason, I have not met in this class with that unconquerable nausea which prevents a sufficiently deep plate being worn.

It is a disadvantage that in this class we cannot bring the margin of the plate further forward than the first bicuspid. This prevents our making use of the *convexity* of the jaw to get the suction chamber previously described; but the *concavity* of the palate, which in this class is usually large, regular and subglobular in shape, will give us the required conditions of the convex part of Fig. 30, only in reverse, the soft part being represented by the plate, and *vice versâ*. We must not expect so strong a suction in this class of cases as in the first; but as there is not so much tilting strain in eating, with care we may generally achieve success. As a rough rule, we may say that whatever part of the upper or

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lower surface of a plate will hold water is available for retaining it in the mouth by suction if it fits accurately.

In every suction case great care must be taken that the piece is not tilted, by simply shutting the teeth, or it will never become firm; on the contrary, the act of biting ought to steady the upper and make it set more firmly in its proper position. On this account it often becomes a matter for consideration whether a lower piece is necessary or not, patients desiring to have only an upper denture. I have known a piece stay up when only the six lower front teeth remained; but we must give the patient credit for a good deal of management and good will, making this an exceptional case, and should feel justified in insisting on a lower being worn as well under such circumstances. A piece can generally be kept up if the second lower bicuspids remain, or if a first molar remains below on one side and a first bicuspid on the other. As an approximate guide, where there is any doubt, draw an imaginary straight line across the mouth, connecting the two lower posterior natural teeth, or for greater certainty do it with a piece of thread, and tell the patient to close his or her mouth; then where the line crosses the gums of the upper maxilla there the posterior line of the force of the bite will come. If this is half an inch or more behind the anterior margin of the superior alveolar ridge success may be safely predicted, but in proportion as it is less than this will success be more and more doubtful.

There is hardly a wider range of difference in the conditions we are called upon to treat in the mouths of our patients than exists between the relative positions of the upper and lower maxillæ when at rest. In some individuals the upper front teeth overhang the lower by half an inch, giving their owner a retreating chin with a deep double or furrow between it and the lower lip. In others the lower teeth close more or less outside the upper, giving the bite known as underhung.

When the teeth are lost, the changes which take place in

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consequence of absorption make this relative difference of position still greater and become a matter of much importance to us when called upon to replace the loss. Sometimes there is a space of an inch and a half between the upper and lower gums; at other times we can hardly find room for the construction required to make our denture of the requisite strength.

In suction uppers where the upper maxillary ridge is small, and the patient retains his natural lower teeth which bite considerably outside it all round, it is well to make an edge-to-edge bite; allowing the edges of the lower front teeth, which are often of some thickness, to be a trifle in advance of the upper, and setting in the upper masticating teeth so as to bite only on the lingual two thirds of the masticating surfaces of the lower teeth, we must sacrifice some masticating surface for the sake of having a steady denture.

If this position of the back teeth too much cramps the action of the posterior margins of the tongue in swallowing and speaking, it may be well to bring the molars more forward by omitting a bicuspid from each side, using small teeth and grinding away the posterior lingual cusp or angle of the last molar on each side.

Where the lower front teeth still remaining so far project that there has been no choice but to allow them to bite well outside the upper teeth there will not be found much difficulty; the bite tends to push them backwards and upwards. The firmest suction upper I have ever seen was such a case in which after wearing an hour or two the patient had some difficulty to remove it, using both hands and tilting it in every direction.

When the lower front teeth bite within or just opposite to the superior alveolar ridge and the upper teeth are not required to overlap them much we shall have a very satisfactory shut. A high bite even is not so tilting as an overlapping one, which latter condition may give us some difficulty; the reason of which, I think, the following considerations will enable us to understand. When the upper denture is tilted by the

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occlusion of the lower teeth it becomes a lever, the force of the bite being the power, the fulcrum being some point in front of the alveolar ridge, the material between which and the striking point of the lower teeth is one arm of the lever, the other arm being all that part of the denture posterior to the fulcrum. The closure of the lower teeth pushes upwards one arm of the lever over the fulcrum and the other, that is, the palatal portion of the denture, is depressed. Thus the palate is brought down behind, air enters, and the plate falls.

The relative power of this lever in different bites will be found by continuing, in imagination, the line of the force of the bite, until it passes the alveolar ridge, and then drawing a perpendicular to it from the point the palate turns forward over, *i. e.*, the fulcrum.

FIG. 31.

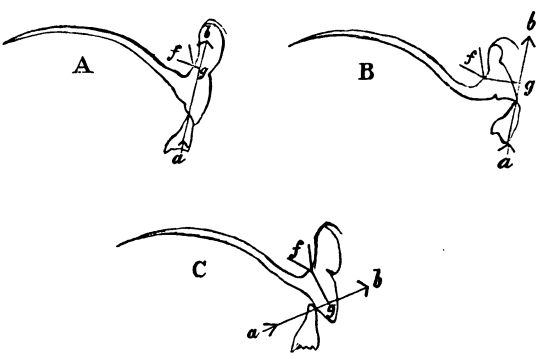

Diagram to show relative tilting leverage of different front-teeth bites. In each figure *f* is supposed to be the fulcrum on which the piece tilts; *a*, *b*, the direction of force given by the striking of the lower incisors against the upper. *f*, *g*. A line drawn at right angles to *a*, *b*, from the point *f*, will give the tilting leverage of the bite. A comparison of the lines *f*, *g*, in each case will give relative forward tilting tendency of the bites.

The length of this line is that of the direct leverage. Fig. 31, A B and C, are diagrams to show the relative tilting powers of the leverage in three different bites; *a b* is the

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direction of the force, *f* the fulcrum, and *f g* the length of leverage in each case. It will be noticed in fig. 31 c that the direction of the force is not that of the motion of the lower jaw; it is supposed that the lower teeth in c, striking against an inclined plane, slip along it and so force the upper teeth forward in the direction given.

When a tooth bites against an inclined plane as at c, it acts with the power of a wedge as well as that of a lever, and this power is in inverse proportion to the deviation of the incline from the direction of the bite, that is to say, if the lower teeth in closing one sixteenth of an inch, after touching this incline, move it forward a fourth of that distance, it would do so with four times the power of the direct bite.

We learn from this that wherever we have an overlapping bite we must be careful to keep the front teeth from touching, or if they must touch, it is better to let them check against a shoulder in the vulcanite behind the front teeth than touch an inclined plane. The following case is an illustration of the difficulties of an overhanging bite.

Mrs. F— was wearing a very comfortable suction upper which, however, she was not satisfied with because she did. not show any of the teeth, and, therefore, a new upper was determined on. The teeth were arranged on a wax trial plate and adjusted to the mouth. When completed the fit of the piece was good and suction sufficient until she closed her mouth, when the difficulties of the bite began to unfold themselves. A wisdom tooth remained on each side below, but these had fallen forward and inward so as to present only their posterior external surfaces to the bite. There were no other molars, and the bicuspides also leaned so much inwards that the upper bicuspides could not be got to check against them, their inner cusps having to be ground away in an inclined plane. The lower front teeth bit just opposite the pins of the upper teeth. The result was that when the bite was on the wisdom teeth the piece glanced forward, and when she bit against the front teeth she tilted it.

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Fortunately the patient bore the failure comfortably, informing us for our encouragement that the Dentist who made the piece she was wearing was obliged to make it over again several times. After several failures success was accomplished by bringing the vulcanite to bite behind the lower wisdom tooth as shown at Fig. 32 *a*. To sustain the wear of mastication, as there was not room for a mineral tooth, it was found necessary to stud the surface of the vulcanite with several small screws of platina wire.

FIG. 32.

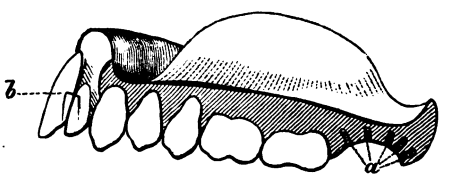

Diagram of Mrs. F—'s upper; to show method of preventing a suction upper from sliding forwards in the mouth when the bite has a tendency to make it do so. Part of the side is cut away to show position occupied by alveolar ridge. *a a*. Platina screws. *b*. Position occupied by natural lower incisor when mouth is shut.

Artificial front teeth have often to be fitted to roots still remaining in the mouth, so as to look as if they sprang out of the natural gums. In order to get a natural appearance in such cases it is necessary that they should be arranged to the mouth on some temporary base plate. The ordinary pink modelling wax is sufficiently strong, if supported by the gold strengthener, to be used in the finished piece. It is very easy to manipulate, and is readily removed from the teeth, if required, by boiling water; but whatever material is used as a trial base plate must be moulded on the model on which the piece is to be vulcanised. To make such a piece successfully the finished piece must repeat with exactness the relative positions of the teeth as they have been tried in to the fitting surface of the trial plate; and this can only be done if the trial plate is moulded on the model to be vulcanised on, and this fit maintained in its integrity. This

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caution is necessary because, if the wax plate is moulded upon a second model kept for reference, or moulded to the mouth in trying the piece in, the result may be imperfect from the trial piece not going exactly in its place on the model, so that the resulting fit, which will be that of the surface of the model and not from the wax, will not be in the same position relative to the teeth as the wax was.

Some workmen, I believe, do not use the original model at all, but simply flask the finished wax denture; and after separating the two halves of the flask, remove the wax and pack in rubber instead, in a manner described, as a preliminary step to packing on the model, p. 53. This method I consider to be wrong in principle. With the utmost care we can only approximate to a perfect model of the mouth when the impression is taken in plaster of Paris. Whatever slight errors are in the original model must be perpetuated by the second impression together with fresh imperfections of its own; and as it cannot be so sharp as the first impression, such good suction or steady fit cannot in my opinion be expected from this method; but in this I am not speaking from experience, as it is a plan that never sufficiently commended itself to my mind to induce me to try it.

Since using the method of packing directly on the model without subjecting it in any way to the strain which takes place in the process of screwing up the flask, such confidence has been gained in the merit of an exact fit that cases have been undertaken which would not previously have been attempted as suction pieces. I will illustrate such a case as has been presupposed by the case of Mrs. H—.

This lady's upper jaw presented a full regularly shaped upper ridge, with a deep scoop-shaped concavity. The roots of all the front eight teeth remained in their sockets in a healthy state, a little filing being all they required. Sufficient lower teeth remained to give a good bite, and as there was plenty of room in the mouth, a vulcanite suction upper was determined on.

A plaster upper impression was taken as well as one of the

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lower in Godiva, and, with the help of an old piece she had been wearing before the canines gave way, an approximate bite was made. The wax trial plate was moulded on to the model, and as the vault of the arch was moderately deep, the casts for striking up the strengthener were made from the model with the wax on it. The strengthener, when ready, was slightly warmed and dropped upon the wax, so as to fix itself in it, and the teeth were let down to fit over the stumps on the model and attached to the wax plate by dropping melted wax behind them. The space posterior to the bicuspides was filled up with wax in block, so as to give the bite and prevent the patient in trial from biting the teeth out of position. In this state the piece was put in the mouth and the teeth readjusted, so as to exactly cover the stumps. Such of the teeth as were loosened by this process were refastened in the wax by first wiping as dry as possible and then passing a hot instrument through the wax down to the pins of each tooth, first on one side and, when that was cold, then on the other. The piece was then replaced in the mouth and finally adjusted.

It was now placed very lightly on the model, but the alterations which had been made in the mouth would not let it sit readily into its place, several of the teeth resting unduly on the models of the stumps; to remedy this the plaster where the teeth rested was freely cut away until the wax went quite down into its old place without the teeth having been moved. The teeth being right by the mouth, must not be altered by the model again, and as no vulcanite is to go under their front edge, it does not injure the fit of the piece to scrape away the plaster there. The wax piece being safely on the model was fixed by two drops of melted wax, one on either side. Holes and notches were then scored on the front of the model to give a retaining surface, which was then covered by a batter of freshly mixed plaster, which was brought over the front and tops of all the teeth so as to form a cap to hold them in position when the wax was removed. When the plaster was sufficiently hard this was done by

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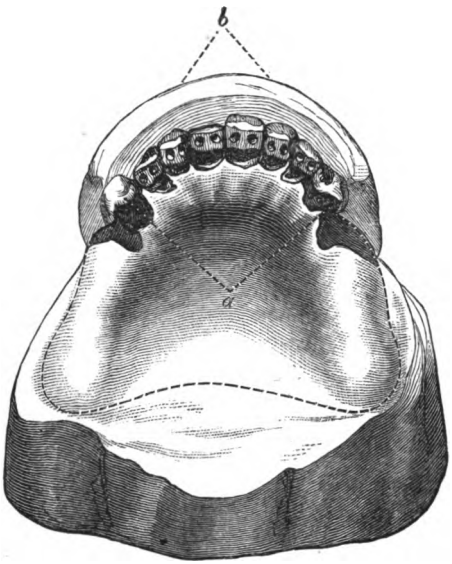
boiling water, and the model presented the appearance shown by Fig. 33.

FIG. 33.



Method of packing piece, after fitting the teeth to stumps or gums in the mouth. *a*, *a*. Eight front teeth, after having beentried in the mouth on a wax plate, replaced on the model and kept in position by a cap of plaster. *b*. When the wax is removed in order to substitute vulcanite.

After being dried, warm vulcanite was packed in all the interstices between the teeth and around the pins. In doing this some care is needful, as, if force is used, such as is harmless when packing in a flask, teeth or cap may be started out of position; but if small pieces of warm rubber are used, cut with some regard to the shape of the place they are intended to fill, and packed and built rather than squeezed, a little time instead of much force is all that is required.

A pattern of thin vulcanite was now cut out so as to reach up to the rubber already packed and cover the desired surface on the model. This surface was then painted over with the chloroform solution of rubber, and when this was dry the

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pattern was put on in its proper position and pressed with the fingers into all the irregularities of the model. The back teeth were now mounted in wax over this soft rubber to the bite, the front teeth of the lower model which interfered with the proper closing of the bite being cut away.

In putting up the back teeth in wax as little as possible was used, and that only on the insides of the teeth; and while in the bite the contour outside was built up with rubber. Plaster was then added in continuation of the cap already placed so as to support the back teeth in this way as well as the front; and when this was sufficiently hard the wax inside was removed, the strengthener set in place in the vulcanite as previously described, and the rest of the contour inside the teeth filled up with vulcanite. The piece was then flasked and completed; it answered very well.

The method here described for mounting the back teeth may often with advantage be applied to the whole denture where the front teeth have vulcanite outside them, instead of the method of twice vulcanising described (in the December number of the Journal.) After trying a piece in the mouth and making the bite, remove all the wax outside the teeth and pack rubber on the model and around the teeth instead, trusting to the bite and wax inside to keep the teeth in position; then remove from the bite, and having a good retaining surface on the model pour plaster so as to cap and support all the outsides and tops of the teeth, and trust to this plaster cap for keeping the teeth right while you remove all the remaining wax and supply its place with rubber.

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CHAPTER V.

PARTIAL VULCANITE UPPERS.

PARTIAL upper cases, for which vulcanite may be advantageously used, can be divided into two classes—those in which there are no natural teeth posterior to the canines and those in which one or more of the masticating teeth still remain. In the first of these classes more difficulty will be met with in supplying the deficiencies than in the second; they have a tendency to drop either towards the front or back of the mouth, and the shape and position of the remaining teeth make the adjustment of any clasps or stays a matter of considerable nicety. From its lightness and adaptability, such pieces will generally be more readily and successfully made in vulcanite, although in some cases there are special reasons in favour of a gold plate.

A single upper central alone should not by choice be allowed to remain in a patient's mouth; but there are cases where age or ill-health forbid an operation, in these we must sacrifice appearance to utility and allow a gold wire to clasp the tooth, coming round on the outside close to the gum so as to nip the tooth on the antero-posterior diameter; or two slight wire stays may be inserted in the piece so as to grasp the neck of the tooth on its lateral diameter in a somewhat similar manner to that described for cases of two centrals (see Fig. 34). When the piece has been worn a short time it will often be found, by opening the wire a little, that it is no longer required; it should then be removed.

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The Rev. S. A—, a clergyman of nearly eighty years of age, of infirm health, had been wearing a vulcanite denture supplying all his upper teeth except one central and a second molar. The molar having given way from decay, the piece dropped in his mouth and was unwearable. An operation being out of the question, it was determined to reset the piece and clasp the front tooth. To do this the under surface of his piece was reduced by file and sculper until no more material remained than was sufficient to act as an impression tray. A thin layer of "extra soft Godiva composition" was then placed over the mucal surface of the piece, and the denture put into its place in his mouth as hot as he could bear it. He was then directed to close his teeth until the natural bite was attained, and in this state he was kept until the composition was quite hard, when the whole was removed. All superfluous "Godiva" was trimmed away and a model in plaster was made from the impression and set in the lower half of a flask. The piece was then prized off the "Godiva," leaving it on the plaster. The composition which filled up the vacancy where the molar tooth had been was carefully cut away almost down to the plaster. The vulcanite surrounding this part on the piece was fresh roughened and the piece replaced on the "Godiva." The place of the molar tooth which was now empty was then filled with wax and a tooth inserted.

At the same time a place had been filed for the gold wire by the front tooth, and this was inserted in wax in the same way as the molar. The upper part of the flask was then put on and filled with plaster; when this was set it was separated, the Godiva, remaining on the lower part in consequence of having been previously separated, was removed from the impression by hot water as well as the wax in the upper part of the flask. The rubber was packed to supply the place of the composition and the wax in the ordinary manner.

Although this method of packing rubber between two parts of a mould and then screwing them together is not nearly so good as that of packing on the model, and is not

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even so good as the use of a tin die to vulcanize upon, it is the only method available when a piece is reset. In order to get good results when screwing up with a plaster model, its face should be covered with pattern lead; this shields the fineness of the impression under the pressure of the screw, and prevents the plaster from adhering to the rubber and so being broken when the two halves of the flask are separated in order to see if the right amount of vulcanite has been packed in, a proceeding which is always necessary. When the cut shapes of the rubber packed to cover the base are obliterated there is enough in the mould, as pressure will not efface these outlines until all the vulcanite underneath is solid. When the mould is full the rubber begins to be squeezed out by the channels of escape cut for it in the plaster; this should be cut away with a hot instrument, which greatly facilitates any further overflow, and the process must be repeated until the flask goes quite home without any more superfluous material continuing to escape. After each opening the flask should be boiled in water for about five minutes before again screwing it up. The pattern lead must be removed previously to closing the flask for the last time before vulcanizing it.

The Rev. S. A—'s piece, when finished in the manner described, was quite right as to the bite, and has answered very well.

Cases in which both upper centrals remain are far from uncommon, and if a lower piece is not required can, I think, be generally best made in vulcanite. These pieces have a tendency to drop in front, to prevent which it is wise to put in two slight wire stays to grasp the necks of the central incisors just on a level with the gum. These wires should be flattened where they lie against the tooth, and should only project just beyond the greatest lateral diameter of the necks of the incisors. If made and fitted neatly they do not show. They may be soldered on to the strengthener; this should be made rather deeper in the middle than usual to compen-

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sate for the weakness of this part of the piece caused by the gap for the natural incisors (see Fig. 34). After wearing a short time these stays may often be removed.

FIG. 34.

Design for upper vulcanite piece when the natural centrals remain in the mouth. *s*. Gold strengthener made deeper in the middle to compensate for the weakness occasioned by the presence of the natural incisors. *a, a*. Fine gold wires soldered to strengthener to act as stays clasping the necks of incisors; the ends of these clasps to be flattened where they embrace the teeth. The right-hand figure is diagram of side view of piece in position, to show place occupied by wire stay when piece is in the mouth.

Teeth for these pieces should be tried in the mouth on the wax base-plate, at any rate as far back as the first bicuspids; and as the laterals and canines will generally have to fit the gum, the method of packing on the model described p. 68, Fig. 33, will be the most advantageous to finish the piece by.

There is some difference in these cases whether the *mucal base** is simple or compound, those cases in which the stumps of some of the back teeth remain being firmer and more satisfactory in mastication in consequence of their support.

* I have taken the liberty to coin the term *mucal base*, meaning that part of the mouth which is covered by and supports a denture. It is *compound* when it contains stumps of teeth.

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It is better, therefore, in these cases to leave any healthy stumps in the mouth, especially if the alveolar arch is narrow and the ridge thin, showing much absorption at those parts where the teeth have been long absent; if any stumps require filing it should be done before taking the impression.

Cases in which the four superior incisors alone remain in the upper jaw are not common, it being rare for the laterals to outlast the canines. As the pieces just described usually drop towards the front of the mouth, and pieces where the front natural six teeth remain generally drop towards the back, it would be natural to infer that pieces supplying all the teeth posterior to the laterals would be about in equilibrium; but although my experience so far points in the same direction, the cases are so few that I have not sufficient evidence to do more than make the suggestion.

The following case, which presented a difficulty in the bite, may be interesting:

Lady F— had only the four incisors, which were long; she had plenty of lower masticators, making it very undesirable to give her springs. She had been wearing a vulcanite upper until she lost her last molar, and this piece she still managed to use, which encouraged the hope that a new upper would be worn. The lower canine bit close behind the upper lateral, as shown, Fig. 35.

An impression was attempted to be taken in plaster, but failed in consequence of the length of the front teeth and the nausea which came on. A model being made from a "Godiva" impression, and a bite made, a gold strengthener was struck up, as shown, Fig. 35.

Two flat canines were backed with gold and attached to the strengthener with wax by the bite, the strengthener being slightly raised from the model to allow for the thickness of vulcanite on its under surface. The teeth and strengthener were then invested in plaster and soldered together. As there was not room in the bite for the plate to go up to the anterior canine, the back of this tooth was strongly

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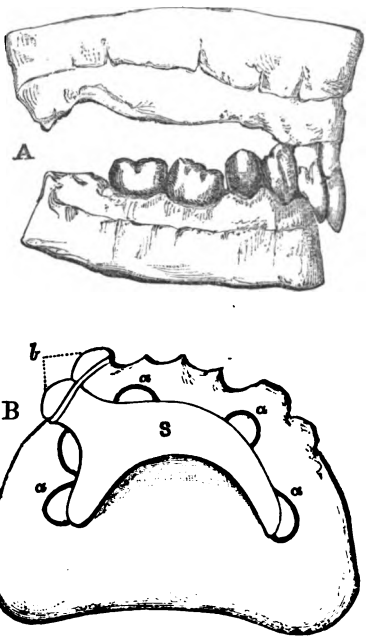
soldered to that of the posterior tooth along their adjoining edges.

Fig. 35.



A. Model of Lady F—'s case, showing close bite of lower canine behind upper right lateral.

B. Outline of Lady F—'s piece. *s*. Gold strengthener. *a*, *a*, *a*. Wire of attachment. *b*. Two flat canines soldered on gold backs; the posterior one is soldered to strengthener, the anterior one is soldered to posterior tooth along its posterior margin.

The strengthener with teeth was then warmed and pressed on to a wax plate which had been moulded to the model, and other teeth were adapted to the bite, the piece then tried in, and after a little adjustment gave every sign of success. It was vulcanized by packing in the ordinary way upon a tin die, but when finished, though the fit was apparently good, showed no disposition to stay up. In order to get a better model the piece itself was used as an impression tray. The

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vulcanite was reduced on the mucal surface until only a thin layer remained; this was loaded with a thin layer of plaster of Paris and placed in the patient's mouth. She was then told to close her teeth until the bite was right, and keep them shut whilst the plaster was setting.

This method of resetting a case, which was adopted from Mr. Oakley Coles' work, I have found excellent on many occasions; but since the introduction of the "extra soft Godiva composition" generally substitute it for plaster. It is neater, and if put in hot and left until quite hard it is to be depended on in most cases.

A piece when reset in this way should have the impression filled with plaster and set at once in the lower half of a flask. When sufficiently hard the piece containing the plaster of the impression must be carefully separated from the plaster of the model which remains in the flask, as, if left on and the upper half of the flask filled with plaster without this precaution the model will most likely be broken when the flask is opened. Having taken the piece with the plaster of the impression from the model, remove all the plaster for an eighth of an inch around the margin of the piece, but leave an island of it in the middle, so as to enable the piece to be set in its true position on the model again. Fresh scrape or file this exposed margin so that the new rubber may have a clean surface all round the edge to unite with; it will not unite with any surface which has the slightest soil of plaster on it. Replace the piece on the model and seal up with wax the crevice which will be found around the margin; put on the upper part of the flask and fill up with plaster, separate when set, and remove all the wax and the remainder of the plaster impression, fresh scraping that part from which the plaster was last removed, and then pack in the manner described in the Rev. S. A—'s case. Lady F—'s piece was completed in this manner, and has answered very well.

Mouths where the six natural front teeth alone remain above are not very uncommon. Dentures to supply the deficiencies in these cases manifest a tendency to drop

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towards the back of the mouth, and therefore require a certain amount of care in their design and execution.

When the tuberosities at the posterior part of the mucal base are well pronounced, it is very important to get a good model of them, as in this case a piece may sometimes be made which will stay up without any clasps. It is often difficult to get an ordinary tray whose posterior external margin shall go sufficiently far back to shield the material of the impression from being slightly compressed by the cheeks on its withdrawal from the mouth, without running a risk of the edge of the tray itself slightly compressing the mucal base: in either case the denture made upon the resulting model will be sure to produce a sore when worn. Even if plaster of paris has been used to take the impression it is very liable to break away here in particles too thin and fragmentary to be correctly readjusted.

When this difficulty is met with, it is a very good plan to make a special tray for the case. Take an impression in godiva and enlarge this by cutting the material away to the thickness of a shilling or rather more from the external margin and around the impressions of the teeth. Pack a single layer of rubber over every part of the resulting plaster model, which the tray should cover, and attach a slip half an inch wide and an inch long to the anterior part to serve as a handle. This will make a very good special tray after being vulcanised and trimmed up.

It is worth some trouble to get a good model of the external and posterior parts of tuberosities when well developed, as if fitted they afford much support. The margin of the piece may be carried here as high as the impression is taken. Further forward opposite the position of the first molar or second bicuspid is often found a frænum which, although it yields to the impression material, is ulcerated if displaced by the edge of the denture. The anterior attachment of the buccinator muscle is about the same place and sometimes advances towards the alveolar ridge: in this case the muscle may throw the piece down when in motion, although when

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relaxed the denture stays up very well. For these reasons an upper piece will often require a shallow margin opposite, or anterior to, the region of the first molar. This can be effected by waxing the model at this part before casting for gold work, or filing away the margin of a vulcanite piece; but posteriorly to this region, in all pieces that are not firmly kept up by clasps and springs, the higher the margin of the base is carried the better.

It will be safest to put wire clasps round the canines in the pieces under consideration, or in many cases they will not be worn from their tendency to drop, the patient not having the strong inducement to persevere which is given by considerations of personal appearance. When the patient has gained confidence in their use and usefulness, he will manage them much better, and the clasps may often then be removed.

The gold wire need not come round on the anterior lingual side of the canine unless it is very short and close to the lateral; generally the neck of the tooth is somewhat exposed, allowing the edge of the vulcanite which adjoins it to be of some thickness; and if there is room for a stout angle of the plate to run in between the canine and lateral so much the better. The distal surface of the neck of the canine cannot usually be closely fitted, or the bulging shape of the crown would prevent the piece from being put in its place. The plate or gold must stand a little off at the neck, and a wire must come round on the outside of the tooth at the margin of the gum, until it, together with the point of plate going in between the canine and lateral embrace rather more than half the circumference of the tooth. In consequence of its conspicuous position it is desirable to make this part of the wire as short as possible, and as the rule is that the whole area of the clasp must grasp beyond the largest diameter of the tooth, it is advantageous to get as much of the mesial side surrounded as possible.

But the power of this clasp will not be sufficient to keep the plate from dropping unless some part of the denture

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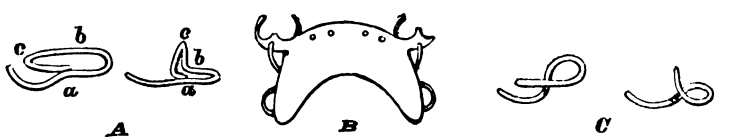
rests against the bulging distal surface of the crown of the canine. The action of the clasp may be illustrated in the following manner:—Take a common walking stick and hold it a few inches from one end between the thumb and second finger; the stick will now drop into a perpendicular position, and cannot be kept in any other without a good deal of effort; but by placing the forefinger against the stick at a short distance above the thumb and second finger, it may easily be maintained in any given angle.

Sometimes this support may be obtained by allowing the first bicuspid of the denture to rest against the canine; but as it is not capable of much adjustment, it is better to make use of a point of gold plate or wire. A convenient clasp for these cases may be made by bending a piece of wire so as to have an angle to rest against the side of the canine, a free end to clasp it and a loop to enter into the vulcanite under the first bicuspid to serve for its sttachment (see fig. 36 A).

FIG. 36.



A. A convenient wire clasp for canines in vulcanite pieces. Bend the wire in one plane as in the left-hand figure and solder the end at *a*, then bend up the angle *c* at right angles across *a b*. The clasp is seen as it would be in position in the right-hand figure, in which *a* comes round the canine at the edge of the gum *c*, which may be flattened a little at the angle, stands against the distal surface, and the loop *b* enters the vulcanite.

B. Strengthener, with plate bands attached. The left-hand stay is only made different from the right when there are canines with diverging points.

C. A simpler form of wire band for the same purpose.

If the necks of the canines are very long it may be better to fit bands of gold plate round the teeth and solder them to the strengthener (see fig. 36 B). Sometimes the long

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axes of the canines diverge so much that they will not allow the clasps of the piece to pass over the crowns; in this case we must put a stay on one side which shall fit closely to the neck of the tooth on its distal and lingual sides, and as much of the mesial as possible, but not coming round at all on the outside. To put the piece in the mouth it must be tilted and put back, and rather to the other side of the mouth to that which has the stay adapted to it; the free ends of the stay must then be tucked into their place, and as the piece is brought forward the clasp is slipped over the other canine and the denture pressed up into its place.

There is a modification of this class of cases in which good judgment is required in deciding whether gold or vulcanite will be most successful. The patient has been content for some years with the masticating power of the six upper front teeth which have in consequence been forced into a protruding position, when the disfigurement caused by the loss of a lateral has obliged him to seek our aid. From the condition of the bite there is not usually much room to spare in the front of the mouth, the palate being flat, so that the thickness of vulcanite is disadvantageous; on the other hand, the difficulty of putting clasps which will keep a gold piece steady, is considerable. In other words, a vulcanite piece is the easiest to make successfully, but a gold piece is the best when successfully made. For average cases, however, we shall succeed very well if we make our gold strengthener and the attachments for the clasps, &c., so as to have a minimum of vulcanite in the front of the palate, paying especial attention to keeping the substance here as thin as possible. The canines in these cases are usually divergent: it will be well, therefore, to put a stay on the side of the missing lateral, and a clasp on the other (see Fig. 36). If the lateral has left a decent stump, a pivot may be inserted in the denture to act instead of the stay; this can be done in the following manner:—Drill the stump for the pivot wire, and take the impression by Mr. Hutchinson's method, as follows, so as to get the correct direction

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of the hole reproduced in the model. Take a short old tube pivot tooth with the pin in it, warm the pin and thrust it through a small disc of gutta percha which is required to take the impression of the stump. Warm the gutta percha and push the pin up into the stump so that the pin goes up as far as is wished. Remove it once or twice to see that it comes out readily, if necessary enlarging the hole in the stump until it does so. Then take the impression with the pivot tooth in the mouth. It will come out in the impression and then on the model as in the mouth, and when removed from the model the hole left by the pivot will have the correct relative direction to a denture made on that model. A tongue of perforated gold plate should then be struck up to cover the stump and extend over the palate a third of an inch, and a pin must be soldered to this to go into the hole in the stump on the model; this will serve to strengthen the lateral, as well as give firm hold to the pivot. It is better not to solder this tongue to the strengthener, as they are more manageable separately. Having previously adjusted the strengthener, teeth, bands, &c., on wax, remove them, and pack the first layer of vulcanite on the model about the thickness of No. 10 plate gauge; then warm the pivot and tongue, and press them into their right position. The piece may now be finished by the method described pp. 68 and 69. It is often advisable in these cases to raise the bite a little.

Where one or more of the masticating teeth remain in the upper jaw, we may classify the mouths into two heads, so far as the difficulty of retaining the denture is concerned: those in which it is the only tooth in the upper jaw, or if there are more they are on the same side, and those in which support can be had from teeth on both sides of the mouth. When there is but a single tooth left, it is to be considered whether it had better be removed or not. If the patient has worn teeth before, the mouth a good one for a suction plate, and not likely to undergo much change from absorption after its removal, together with that of any

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stumps which may be necessary, it will be as well to extract it.

But I have often seen the benefit of a single tooth. A bicuspid, molar, or even a wisdom tooth, if moderately firm and well fitted, will give a steadiness in wear and mastication which will save a tedious ordeal of apprenticeship to a patient unaccustomed to artificial teeth. In cases where much absorption is likely to occur, a single tooth may be of much service, enabling the denture to be placed in the mouth much sooner, and retained much longer before a new piece or a refit is required.

It is true that in the course of a few years it may be expected to give way even under favorable circumstances; but in the meantime the patient has become familiar with the use of artificial teeth, and will more readily accommodate himself to a suction piece. The mucal base also will have settled down into a much more permanent shape, which will not be much affected by the removal of the single tooth. If the patient, however, then contemplates having a second piece, it will be well to reset the old piece as a suction piece immediately the tooth is extracted, and wait a little for the absorption of the walls of the last alveolus before making the new denture.

Clasps.

In my last chapter I spoke of clasping a tooth where only one remained in the upper jaw; and as this clasp, to be of service, must be made with some regard to the particular conditions of the case, which will require further description, this will be a convenient occasion for also considering the general principles which are usually involved in the application of bands or clasps.

It comes under observation so constantly that bands have been injurious by inducing caries to teeth around which they have been worn, that, although their usefulness often

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outweighs the disadvantage, in considering when, where and how a denture should carry clasps, this tendency should never be lost sight of.

Therefore, in the first place, we must always consider it better to do without if practicable; and I think, for the same reason, it will be good Dentistry, where we do elect to use them, to put few, making these as efficient as possible, rather than place a clasp around every available tooth, in order that as one fails another may do service, and thus ensure the greatest amount of mischief which may arise from this source. As a rule, with some exceptions, I would say to a young practitioner, Put as few clasps as will satisfy your patient with the stability of his denture: you will rarely in the future have to regret a meagre supply of bands; for, if the piece is well made in other respects, the longer he wears it the less of their support will it require.

Vulcanite clasps perhaps injure teeth less than gold ones, although of this I am not sure; but from their clumsiness, want of adaptability, and liability to fracture, gold is to be preferred for a clasp of any importance. A large exception, however, must be made in favour of vulcanite when it may be allowed to entirely encircle a tooth, in which case it is often of great service in giving a denture steadiness.

Each tooth, as a rule, should be gripped by its own clasp. Our experience in regulating teeth will have taught us that we must not try to gain a support by pressing two distant teeth towards or from each other, as eventually the teeth will be moved and the hold lost. Our next consideration will be to hold up the plate with sufficient firmness and the least possible strain on the tooth which is clasped. Suppose two teeth on opposite sides of the mouth to be clasped and a straight line drawn connecting them; then the more nearly this line divides the denture equally the better. For it is evident that any tendency of the plate to drop must be either before or behind, in fact it will oscillate on this line. Whichever side drops the other will be thrown up against the mucous membrane, and hence the more nearly does the

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denture balance on this line the less strain will fall upon the clasps.

From this consideration we shall see that it will often be advantageous to carry a plate farther back in the mouth than the clasp, even when there are no teeth to be supplied posteriorly to it (see Fig. 37).

FIG. 37.

To show that if the plate is carried back to *c*, as in B, it will prevent the front teeth dropping, as at *b*, A.

But where we have to contend with a tendency to drop on the other side of the mouth to that of the tooth clasped we cannot usually get any support by continuing the plate on the side of the tooth opposite to the drop, as the mucous membrane here generally takes a more or less vertical direction, being the alveolar margin.

In clasping any tooth some consideration must be given to the direction of the diameter of the tooth to which the principal grip of the band is given; and in cases where a lateral drop is anticipated this must be specially attended to; the grip being always most effective if it is on the line in the direction of the fall. As an illustration I will suppose the case to be fitted where only one tooth remains in the upper jaw. Great care must be taken that the centre of the clasp is the centre of the tooth, the lingual side of the clasp, which is usually rigid, must fit the tooth snugly, or in tightening the adaptable part of the clasp instead of holding the piece firmer it will draw it a little on one side, and so bring it down, thereby preventing it from settling properly into its place and being partly supported by suction.

The impression of the tooth to be clasped should be well taken as possible on its lingual and mesial aspects, the clasp, in vulcanite pieces, being generally represented by allowing

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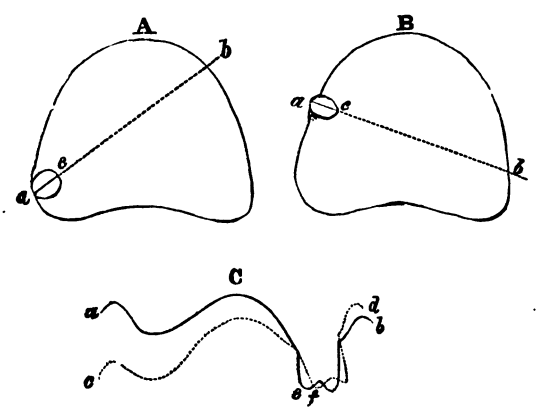
the rubber to surround the tooth here carrying it quite up to the masticatiug surface.

The Dentist must estimate from the disposition of the weight of the denture where it will be likely to drop the most, and a straight line drawn from this point through the clasp will show the direction in which the strain of the clip must be.

For instance, if a right upper wisdom be the remaining tooth the denture will probably have a tendency to fall most at the position of the left canine. If, then, we draw a line from the position of the left upper canine through the centre of the wisdom tooth, it will give us, in the points where it cuts the tooth, the direction in which the grip must be taken (see Fig. 38 A, *a*, *c*). Or if a right upper second bicuspid B; *a*, *c*, will be the right grip to take.

FIG. 38.



A. Figure to show where the grip of the band should be taken in a mouth of one tooth. B. Ditto, ditto. C. Figure to show that to prevent the plate dropping from *a* to *c* the band should come high on the lingual surface of the tooth, so as to press against *e*.

The drop of the plate will tend to throw the lingual side of the band, on the line of the drop, towards the tooth on its lower or coronal margin, whilst the outside or movable part of the clasp will be thrown towards the tooth, in the line of

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the drop, next the gum (see Fig. 38 c). To counteract the drop it is therefore important that the inside of the band, whether of gold or vulcanite, should come as high as possible; and if in putting it in the vulcanite should require easing to go over the tooth, care should be taken only to file or cut away from that part which fits the neck of the tooth.

The buccal part of the clasp is free and adaptable, and must also possess a certain amount of elasticity by means of which it grasps the tooth. For these amongst other reasons it is best made of gold.

The force of the grip which the band has to take must be proportioned to the strain which it has to bear, that is, the weight which it will have to support. This grip will depend upon the stiffness of the gold used for the band which, other things being equal, depends upon its thickness. We must not, therefore, use gold of the same stoutness for a deep clasp that we do for a narrow one, as this would give us a rigid unmanageable band which we shall have great difficulty in adapting satisfactorily to the mouth, and which will give the patient unnecessary trouble in taking the piece out and putting it in; besides trying unduly the stability of the tooth, which in the cases where deep bands are required, is often a little infirm. This rule will apply in all cases where bands are used; those under consideration do not usually present teeth which are very short on the model; but where short teeth have to be clasped, round wire or number ten plate gauge thickness gold plate will be indicated; whilst the longer the teeth, or, in other words, the deeper or broader the band, the thinner should be the plate used, very long teeth with the roots partially exposed sometimes requiring it of the thickness of number six gauge plate.

Upper dentures for mouths in which both wisdom teeth remain are more easily made in vulcanite than gold; although there is not usually any serious difficulty met with in adapting a gold piece, if there is any special reason for doing so. One of these, which it is well not to lose sight of,

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is the facility for being repaired or added to without injury. In this respect gold pieces have certainly the advantage, and are therefore preferable for patients going to out-of-the-way parts of India or the colonies, where aid is much more likely to be obtainable to repair a gold than a vulcanite piece.

In the cases just spoken of the drop is in front; the bands must therefore grip the teeth on their antero posterior diameters. This may be done by bringing a short clasp round the posterior side of each tooth, from the lingual side of the plate for half the width of the tooth, and allowing the buccal clasp to turn the posterior corner of the tooth so as nearly to meet it. The mesial aspects of the teeth must be closely fitted as high as possible with gold or vulcanite.

Mouths, having several upper teeth remaining, placed so that any three of them will form the angles of a triangle, which if described on the plan of the model, would occupy a considerable portion of the mucal base, will usually wear a vulcanite piece without bands. The natural teeth in such a position give so much steadiness in wear if closely fitted on their lingual aspects that such a denture if packed on a good model rarely gives much trouble. Should there be a molar on each side the mouth, rings of vulcanite may be allowed to encircle them. These not being elastic do not rank as bands, but may be converted into such by being cut through with a saw on the outside.

Sometimes the teeth, in the cases under consideration, have different inclinations, so that you cannot get an impression without a considerable drag. This may be of consequence, as not only is the resulting model of the tooth gouty, but the representation of the adjacent mucal base is also rendered defective. This difficulty may be overcome in the following manner:—Pass a piece of floss silk round the tooth which causes the difficulty, and tie it low down on the side of the undercut, leaving the ends of the knot an eighth of an inch; if it is a long tooth repeat this twice or thrice at equal distances. Mix a little plaster of Paris very stiff, and with a spatula build up the tooth on the side of the under-

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cut, so that its shape may present no difficulty to taking a perfect impression, the ends of the silk will hold the plaster in place when set whilst this is being done. On the removal of the impression the plaster can be taken away; by cutting the silk on the other side of the tooth, it can then be adjusted to its right place in the impression, and stuck there with a little varnish before pouring the model.

This method of taking a model is also useful sometimes for lower cases, where, as well as some front teeth, there is a posterior molar which has fallen forward, making it difficult to get a model without a drag.

The following case may be taken as a type of a class which give rise to a question of some delicacy. Miss S—, a prepossessing young lady of about twenty, presented herself with all the upper incisors in such a hopeless state from decay and alveolar abscess, that they were extracted, together with several of the masticating teeth. It was evident that within twelve months the absorption of the alveolar processes would make a considerable alteration, or a new piece necessary. The difficulties of such cases lie in three points. In the first place you do not like to do good and difficult work which will not last six months in a presentable condition, and then let your patient have a patched piece for a permanency, which will not do you so much credit as a new one. In the second place, few patients will pay a full fee for a piece which is only serviceable for six months without having their confidence in your regard for their pockets a little shaken. In the third place if a temporary piece is made for a small fee you are sometimes mortified to find that the patient does not return for the second piece, making shift with the first piece in order to save expense, and thus bringing discredit on your work by wearing it when it no longer presents a creditable appearance.

Perhaps the best way is to charge a fee and a half at one settlement for both pieces, refitting the temporary one, after the better piece is made, so that it may serve as an occasional piece to be worn should the better piece require to be

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repaired at any future time. Harris suggests that the full fee should be charged for the first piece, and a modified one for the second; this would be convenient, but I doubt if a lawyer would consider it sound practice; therefore if it is necessary to settle for the pieces separately it may be well to charge rather a full fee for the first piece, so that should your patient not reappear you are paid for what you have done, and a little modify the price of the second piece, so that together the fee and a half is made up.

Miss S—'s case was treated in this manner. The same attention to appearance in the mouth was paid as if for a permanent set. The teeth were adjusted to the mouth on a wax base plate, and the piece made by packing on the model; but it was not considered necessary to put a gold strengthener, and no more teeth were used than appearance required; a masticating surface being made up in vulcanite. In the course of a year so much absorption had taken place that mineral gum sections were required to give a pleasing appearance.

From the middle of life to old age we meet with patients who, from premature or senile absorption of their sockets, lose a tooth or so every year or two. Such teeth as they retain are rather long, having their roots partially exposed by the recession of the gums which steadily goes on. A vulcanite denture is often best suited to these conditions, as the necessary additions are more readily and comfortably made to it than to a gold piece. There is sometimes a slight warp after each time of repair, which can be remedied in the following manner:—Pour some plaster of Paris into the fitting surface before repairing the piece so as to make a model of it. After cooking see if it fits, and if not, soften by immersing for a minute or two in olive oil heated to 300° F., and press it down in the palate with a napkin. After repairing three times the teeth should be entirely reset on a fresh model of the mouth.

I have not found the relative size of the mucal base any objection to using vulcanite for upper pieces.

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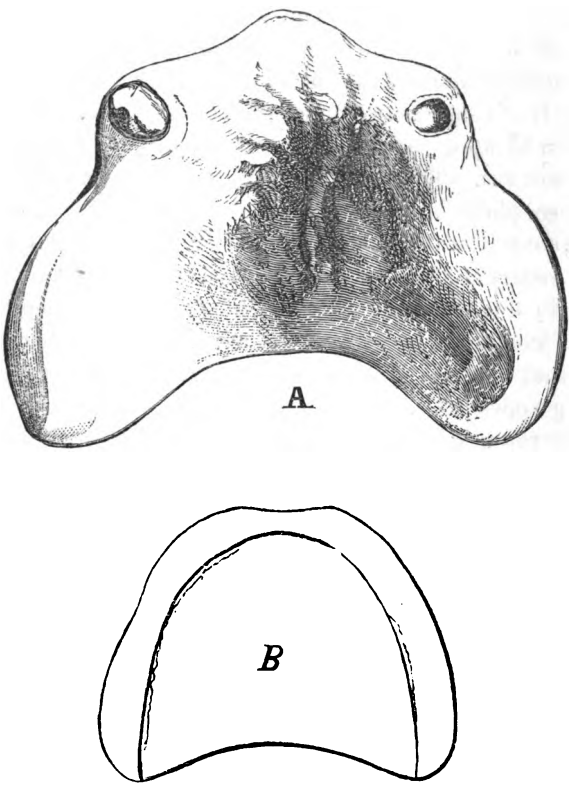
Mr. E—, Fig. 39 A, had the largest mouth I have met with in practice. He would not wear a gold piece, as it would not stay up without springs, and these were such an encumbrance in consequence of the width of the alveolar

Fig. 39.



A. Actual size of mucal base of a large mouth.
B. Outline. Actual size of small vulcanite upper; the inner line indicates the top of alveolar ridge.

borders that the set stayed in its box instead of his mouth. A vulcanite piece was therefore made which he has worn for years. On the other hand, Fig. 39 B, is the outline of a

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vulcanite suction upper of the smallest mouth which has come under notice. This piece was put into the mouth of the patient some years ago when she had some lower masticators to meet it; these she has since lost, but still wears the piece with perfect comfort, although only the six lower front teeth articulate with it.

Time is a matter of importance in the mechanical department of Dentistry; hence the best order of proceeding in rough filing and finishing vulcanite work merits a little attention. The pupil usually makes the mistake of considering difficulty and labour to be the same thing, but his value as a workman will to a great extent depend upon the quickness and distinctness with which he is able to recognise their difference. Difficulty means a want of knowledge, a not seeing clearly how the end is to be practically attained. Labour is a physical matter, a using of the muscles, &c. Both require effort, and if the amount of labour produces fatigue or exhaustion of the physical or moral energy, the labour becomes a difficulty; that is to say, the individual does not see clearly his way through it. In this way the two have become confused, but that they are totally distinct is evident when we consider that it is often difficult to do a thing with little labour, whilst it is very easy to do it with much.

On meeting a difficulty the pupil must pay attention until he sees how to overcome it, or what knowledge he wants to do so; when this is attained it vanishes, although more or less labour remains, and as more than a certain amount of this becomes a difficulty in itself, a little thought may be well expended in reducing the labour to the smallest amount.

The first thing to be done with a rough vulcanite piece in the hand is to determine the outline of its fitting surface, and having marked this with pencil or in imagination roughly file it down to this, holding the file in such a direction that it makes an equal angle with each of the surfaces which form the edge which it is reducing. This will keep the edge thick and sound everywhere. The outline of the mucal surface of the plate will be determined by conditions which have already

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been dealt with. The more nearly the surface of the gum which has to support mastication is at right angles to this force the better the pressure will be borne; whilst, where it is in the same line as the direction of the bite, it does not give any support at all. It will be well, therefore, to cover as much of the former surface as possible, whereas no more of the latter should be covered than is needed to give steadiness and restrain the piece from lateral motion. The outer plate of the alveolar ridge in the posterior part of the lower jaw is often nearly horizontal, whilst the inner side is almost vertical. At this part, therefore, it will be well to keep the outer side of such a lower piece as broad as possible, whilst the part inside the ridge may be comparatively narrow.

The hinder margin of the plate should have a nice even curve for the sake of symmetry, the posterior point being on the line of the alveolar ridge, and reaching just far back enough to cover the slight tuberosities which mark the termination of the alveolar processes. Having rough-filed the outline of the lower surface, our next proceeding is to define the teeth with a sharp-pointed blade or graver, cutting them out at once as cleanly as they are wished to be in the finished piece. The edges of the piece are now filed to their proper thickness, the buccal edges of the upper piece and all the lower edges of lower pieces being filed round and thick, whilst the palatal edge of upper pieces and edges of both upper and lower pieces where they adjoin the lingual surface of teeth must be champered or flushed off to a sharp edge from the lingual surface of the plate, so as to present as even a surface as possible to the tongue when the piece is in the mouth. The parts between the edge of the piece and the margins of the teeth must next be roughly reduced to the desired form.

To reduce a rough surface to a polish the inequalities produced by the implement used have to be removed by something which leaves less inequalities, and so on, until a perfectly smooth surface is attained; but as a coarse material removes these inequalities more quickly than a fine one, the

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gradation in fineness must not be abrupt—to finish quickly a good many changes must be made. After the rough file and scauper should come a bastard gold file, and the end of rough corundum file for the concavity of the palate; then No. 1 glass-paper for the edges and those parts easy of access to it, the concavity of the palate being followed by medium corundum file, fine corundum file, and then a cane and pumice powder; the No. 1 glass-paper being followed by No. 0, with a fine sharp-pointed file to go in between the angles of the teeth, to be followed by cane and pumice powder. Until practice has given the requisite judgment it is easy to tell when an implement or material has entirely removed the scratches of the previous one by using each in a different direction, so that the scratches appear across each other. The piece will now be ready for the polishing brushes of the lathe.

Emery and oil is no doubt the quickest cutting brush material, but great caution must be exercised in its use, or it will reduce the prominent parts of the work more than is intended without taking out the scratches of the depressions. Oil soaks into the rubber and prevents its taking a high polish. Although not quite so cutting, it is perhaps better, therefore, to begin the lathe work with a paste of soft soap, pumice powder, and water, of about the consistence of cream, to be followed on separate brushes by crocus and water, and finished off by either rouge or whiting, which is best moistened with spirits of wine, or in lack of that, hot water.

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CHAPTER VI.

PIVOTING TEETH.

The method of pivoting teeth which will be described in this chapter occurred to me about eight years ago whilst treating a case where other methods had been found to fail. Since that time I have used it almost exclusively in practice. Harris mentions a method virtually the same, and a record of it appeared in the 'Transactions of the Odontological Society,' but experience has modified many of the details, which it may be well to reconsider. One of the principal difficulties which I have met with in its use, and in getting my professional brethren to adopt it, has been to obtain a supply of the instruments and various parts made with such accuracy as to render the time required by the operation of reasonable length. Messrs. Ash and Sons have, however, undertaken to supply instruments, tubes, &c., made from patterns of those now used; and as the time necessary to pivot a tooth with these ranges between three quarters of an hour and an hour and a half, I think this objection need no longer be urged.

The method consists essentially of screwing a metal tube into the stump and fixing the artificial crown on a split pin; and although it will usually be better to get these with the necessary instruments from Messrs. Ash, the following directions will enable any workman to make both.

A strip of dental alloy No. 6 thickness is bent longitudinally around a straight piece of pin wire, so as to form a tube. The wire is withdrawn and the seam soldered up. A short piece of wire is put in one end of the tube and it is drawn

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through the wire plate until it is No. 25 plate gauge size. A good thread is cut on the outside of this tube with a screw plate, after which it is divided with a saw into lengths of half an inch, and a coil of fine wire (old spring wire) is soldered around one end of each length so as to form a shoulder or rim to strengthen the orifice. One tube at a time is then returned to the screw plate, and screwed up until it checks against the rim, in which position it is bored out with a parallel-sided drill scarcely larger than the size of the pin used. For this size tube, which is suitable for centrals and canines, I find that the pin should not be less than 17 plate gauge. For laterals or bicuspids it is better to have another set of tubes, &c., a size smaller.

Platina and dental alloy are used because Sullivan's cement has been found to be the best material as a luting to make the joint between the screw and the sides of the stump perfectly tight, and the mercury in this affects gold injuriously. I have tried for this purpose white lead, gutta percha, mastic varnish, osteoplastic, pitch, and various amalgams, but find nothing is to be so fully relied on as Sullivan's cement; it is smoother than other amalgams which do not set too rapidly, and being out of sight the discoloration it causes is not of much consequence; still, a luting which would allow of the use of gold would be an improvement. The split pins are made by flattening two pieces of platinum wire and drawing them down together through the draw plate to the right size. To prepare the hole in the root and tap a screw in it, three instruments are necessary—an auger drill to bore the hole, and two taps, one of which shall cut the thread of the screw a little deeper than the other, as the torsion put upon the root if the screw is cut at once gives a good deal of pain.

To make them take an auger drill and two old excavators and, after drawing the temper, cut a thread on all of them half an inch long, with the same hole in the screw plate used for the tubes. If you can find a drill which will tightly fit the screw hole without being marked by it, it will be unnecessary to alter it, but if not, file out all the screw marks

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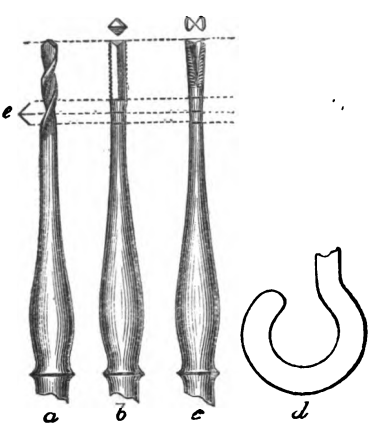
upon it and no more. At a quarter of an inch from the end make a neck in the two taps by filing out all the thread for a quarter of an inch. To make the tap to be first used, file the screw part square until only half the depth of the thread is left on the edges thus produced, and sharpen the end bradawl fashion. The second tap will only require to be mitred to make it cut.

As it is necessary to know when each instrument has penetrated to the same depth in the root as the previous one, three marks are filed on each, the furthest of which is rather more than three eighths of an inch from the end with a sixteenth of an inch between each mark. The end of handle of the two taps requires a turn in order to give

FIG. 40.



Instruments for pivoting.

a. Auger drill. *b*. Square screw tap. *c*. Mitred screw tap. *d*. End of handles of *b* and *c*. *e*. Marks on each instrument the same distance from point. The size of *c* to be No. 25-plate guage. The length from the point to the lowest of the three marks at *e* to be three eighths of an inch plus.

sufficient power in use (see Fig. 40 *d*). The instruments should be tempered to a dark straw colour.

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The following reasons may be given in favour of this method of pivoting. A screw is one of the most perfect and strongest ways of attaching things together; but it is impossible to screw the pin into the root if it is already fastened to the crown, and to fasten the crown on afterwards is very inconvenient if not often impracticable, and after sufficient trial this plan was abandoned.

Platina tubes, taken from tube teeth and strengthened by having gold melted over the outside with a few rough nodules left, have been used occasionally for a long time I believe, but without any mechanical advantage being gained; as to put a tube outside the pin, unless that tube is screwed in, is only to increase the size of the wire without strengthening it. One of the ends gained by screwing in a tube is the protection as a filling which the soundness of the screw joint enables it to give to the root. I have scarcely met with a case in which a tube put in by this method has been loosened by the progress of caries. Another advantage which is claimed for this method is, that in case of any symptoms of periosteal inflammation supervening, the tooth is readily removed to allow the discharge of any pent-up fluid, or of an application being made through the pulp-canal, without injuring the work which has been done; the patient may even be allowed to remove it himself periodically for this purpose.

Roots of teeth suitable for pivoting may be divided into three classes:

First, those in which the pulp is alive.

Secondly, where it is dead, but the peridental membrane is apparently healthy, and there is no fistulous opening in the gum opposite the apex.

Thirdly, where there is a fistulous opening allowing a slight discharge, but the root is otherwise sound and healthy.

The natural crown has sometimes to be removed in teeth belonging to either class, although for those of the first in a larger proportion of cases; in doing this, it is well to keep

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as much of the fang as possible; therefore, instead of cutting the crown off at the neck, do it on a level with the angle of gum which runs up between the teeth, so that a half-round file may reduce the edge of the stump to the edge of the gum evenly. It is necessary to make a transverse notch in the enamel, both on the lingual and labial faces of the tooth, previously to excising it with the cutting forceps, in order to prevent them from slipping. This notch is readily made with a fine wheel by the burring engine. In order to avoid the mischance of wrenching the tooth should the patient make an unexpected movement, the cutting forceps should be held very loosely in the hand whilst adapting it to the tooth, and allowed to settle itself into its own position until you are quite ready by a sudden and forcible closure of the handles, which should be done without hesitation, to effect the excision.

I have a strong suspicion that the shock of this operation paralyses the sensibility of the pulp for a short time, or otherwise we may infer that being diseased it is in a hypersensitive condition, as we usually meet with it. Certainly the pulp gives less pain when extirpated on being thus suddenly exposed than might have been expected, it is well therefore to remove it at once. When the pulp is removed the end of the canal should be at once plugged with tin foil, to prevent the possibility of any septic influence passing through the terminal foramen. In only one case have I seen any irritation follow this treatment, when there was pain and considerable tenderness on percussion for a week, after which it subsided without any inflammation.

The first step towards boring a hole for the tube is to ascertain the direction and depth of the canal, both of which are variable. Thrust a fine steel brooch through a little disc of cork or gutta percha and pass it up the canal as far as it will go; then notice in front and profile the direction which this brooch holds relatively to the crowns of the two contiguous natural teeth. This will give the direction for drilling, which must be borne in mind, and the disc of cork

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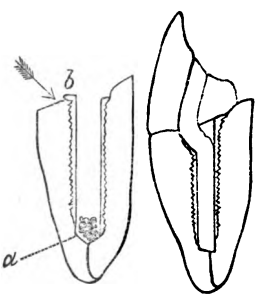
on the brooch will enable you to gauge the depth which can be safely bored; this must be measured off and noted on the drill (Fig. 40 *a*).

A burr thimble is very convenient if the hole is bored by hand. The screw having been cut in the hole with the two taps (Fig. 40, *b* and *c*), the orifice must be a little countersunk with a large burr so as to receive the shoulder of the tube, which when screwed in should come flush with the surface of the root.

FIG. 41.



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Section of roots with pivot tubes.
1. *b*, tube in position; *a*, pellet of wool to guard canal. 2. Root with crown in position.

If the tang end of a drill brooch be thrust into the rimmed end of the tube and the drill end fixed in a hand vice, we shall find that it will hold quite sufficiently to screw the tube up into the root, or an instrument can be kept for the purpose. Having cut the tube the right length and found experimentally that it fits perfectly, we prepare to fix it permanently in its place by smearing both the inside of the root and the outside of the tube with a little Sullivan's cement. In order to prevent the screw clearing this all out before it, it is well to file away a little of the thread at the extreme end of the tube. Before putting any cement in the

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hole in the fang, however, we must prepare a means for removing the surplus which will be carried down before the tube, and prevent it from choking the fine canal at the end of the fang, which in the second class of roots it is necessary to leave open. To do this roll up tight a small pellet of cotton wool as large as a No. 4 shot, and push this up to the extremity of the hole; now apply cement and screw up the tube. A fine hook will with a little teasing bring out the pellet of wool and all the superfluous cement before it. (See Fig. 41, *a*.)

If the operation has been so far carefully performed in its details, I believe no fear need be entertained of its failing in the future in consequence of the progress of decay.

In easy cases we shall choose a tube tooth for the crown, as it takes less time than a flat back and can be put up without drawing the temper of the platina wire, by hard soldering, which is an advantage. Experience enables the operator to judge whether a tube tooth will let down to look well; some range of position, however, may be obtained by bending the pin twice in opposite directions, and making room for the knee thus formed by drilling away a little of the front or back of the orifice of the tube (Fig. 41, *a*). This does no detriment to the stability of the work; indeed, rather helps to prevent lateral motion in the new crown.

In order to manipulate the split wire it is well to solder together the part which is meant to hold the crown with soft solder or tin. To do this, put a little thin whiting and water between the surfaces of the part not to be soldered, and then thrust this part into a hole in the end of a steel instrument drilled the right size on purpose. This will hold the two pieces together in a true position whilst the projecting halves are soldered together. These parts are touched with a little solution of chloride of zinc (osteoplastic fluid) heated and thrust into a little melted soft solder until it is seen that union takes place. The soldered part is now filed so that it will freely pass into the tube of the crown, but

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the unsoldered part which is to go into the tube in the root must not be touched with the file.

The pin is now ready to be adjusted by bending relatively to the crown and root, the former having been previously let down to fit the stump. In doing this, as the pin should be kept as stiff as possible, the division between the halves must be kept in an antero-posterior direction. The instrument previously referred to, having a hole in the end closely holding the pin, will be found a great help in bending it. A model sufficiently good to fit the crown on in the workroom can be made in a couple of minutes by taking two lumps of "Godiva," as large as hazel nuts; with one between the finger and thumb take the impression of the root and harden in cold water immediately, and make a model from this by pressing the other piece into it, the second piece being put in hot water and the first in cold and the pressure repeated once or twice. The second piece when hardened will give a good working model of the root, but the crowns of the contiguous natural teeth will not be fully represented, so that to get the artificial crown the right length it must be tried in the mouth once or twice.

The crown is fastened to the pin with soft solder in the following manner:—A thin strip of common tinned iron is used as a ladle, and a small quantity of solder is melted on it over the gas; the pin grasped by the split end by a pair of pin pliers is touched with a little solution of chloride of zinc, a little of which is also run into the tube of the tooth. The end of the pin is held in the solder, and both heated together until the pin is coated and takes up some of the solder, when it is thrust into the crown of the tooth as far as it will go; as the solder hardens immediately, this will not be far. The tooth on the point of the pin is now heated over a small gas flame until the solder melts again, when it is slipped down into its place by a napkin, and when cold is ready to place in the mouth.

In the first and third classes of stumps enumerated it is desirable to make the joint between crown and root per-

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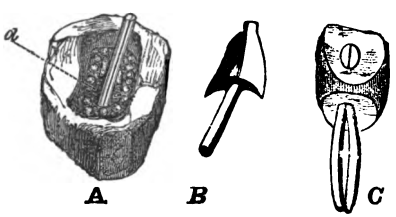
fectly tight immediately, as these give no trouble from periosteal inflammation. To do this, having tried the tooth in and found it fit, take a small disc of Hill's or Jacob's gutta percha and thrust the pin of the tooth through the centre of it, warm it, and press the tooth up in the mouth; if there is too much take the tooth out and trim off the overflow with a hot penknife, and repeat until right.

To fix the tooth, open the split in the pin with the point of a penknife, and close the ends over it with the pliers, so as to leave it open in the middle. (See Fig. 42 c.)

FIG. 42.



A. Flat tooth, with wire invested in plaster for soldering. *a*. Gold foil packed against tooth and over model of stump to hold melted solder. B. Ditto, finished. C. Tube pivot to show method of opening the pin in order to tighten it.

It will now push into its place without any trouble, and be sufficiently firm, whilst at the same time it can readily be removed if necessary.

If the bite, however, is a close one, or the position or direction of the fang such that a tube tooth is not readily adjusted to it, a flat back should be mounted in the following manner:—A flat crown is chosen and fitted to the mouth, but not backed. Take a split pin, of which one end is soldered together with gold, and let this end be rather long. Bend the soldered end so as not to interfere with the position of the crown when both are in their proper positions in the mouth. Fasten pin and crown together with a little

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lump of resin and wax (Ash's cement); now place in the mouth, and, the cement having been a little warmed previously, thrust the pin as far up the tube in the root as it will go and adjust the crown, at the same time pressing the cement well down, so as to take the impression of the stump. Give a minute or two to harden, and remove by grasping the free end of the pin with pin pliers, being cautious not to shift the position of the crown in so doing. Crown and pin are now to be invested in plaster for soldering, and when this is set the cement removed with boiling water. When the plaster is quite hard pack some scraps of waste gold foil around the pins of the crown and over the stump, as a basis for gold in scraps to be melted on (see Fig. 42 A), so as to make a solid gold back to the tooth and a plate to fit the root and hold the pin at the same time. When filed up and polished this has a very neat appearance, and no exception can be taken to its fit or strength (see Fig. 42 B).

During the past six years I have kept a record of pivot cases and their results, and although there may be some omissions, it is, I believe, tolerably accurate in its general results.

Number of teeth pivoted	125
(Inflammation set up in fourteen, of which inflammation was slight in six cases, severe in eight cases, of which four were lost. These all belonged to the second class of roots.)	
Loss from alveolar abscess (as above) . . .	4
Loss from root splitting, all laterals . . .	7
Loss from tube coming out	2
(In one case the tubing had been cleared out by a roughness in the thread of screw. The other had very little sound tooth to hold in.)	

In several instances pivots have been used instead of clasps to retain gold plates, but except for small pieces, or where its use is intended to be temporary until retention by suction has been attained, nothing can be said in favour of them.

In cases, however, where the whole of the tooth next to

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the root to be pivoted is absent, and a very small plate will take both crowns, such a piece will be often more comfortable and sightly than a plate supported by clasps, and much easier to make and firmer than a small gold suction plate. Such a piece may be made, without striking up a plate, by burnishing down some stout gold foil on the model and melting scrap gold over it. In illustration I will give the following case:

Mdlle. S—r had lost the first right bicuspid for some years, and the crown of the neighbouring canine having given away from caries, it was determined to supply both deficiencies with a pivot plate. The root was prepared and a tube fixed in it as previously described. A plaster model having been made of the mouth in this state, a small pattern in lead was cut so as to cover the space between lateral and second bicuspid, embracing also the mesial and lingual sides of the latter tooth. This was laid upon a piece of No. 30 gold foil, doubled six times, and the gold cut out by it. One of the six patterns of foil thus obtained was then burnished down on the model so as to fit accurately, then a second; the two were then annealed to a read heat and burnished together, this firmly united them, and the process was repeated with the remaining four pieces. The result was a plate sufficiently flexible to bear a little adjustment in the mouth. By pressure the position for the pivot was discovered, and a hole made to allow the passage of the wire into the tube in the root. This wire, which was purposely left long, was fastened to the plate on the lingual side with cement and adjusted to the mouth. Wire and plate were then soldered together in this position by investing in casting sand, and at the same time scraps of plate gold were melted over the whole lingual surface of the foil plate so as to stiffen it. Flat backs were then added in the usual manner and the piece finished. An alveolar abscess had to be treated in connection with the pivoted canine root, since which the piece has been quite comfortable.

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CHAPTER VII.

GOLD WORK.

ALTHOUGH it is without doubt principally for the taste required to give a set a pleasing appearance in the mouth, the knowledge required to make it useful in mastication, the engineering required to design it so that it is retained in the best manner, and the manipulative skill necessary to make it fit comfortably, that our work is substantially valued: yet many patients have a strong prejudice in favour of gold, and for many upper dentures it is still by far the best basal support, so that there is as yet no probability of its use being abandoned; and notwithstanding all that may be said to the contrary, so much is dentist as well as patient impressed by the beauty and value of the material, that, coming from the same workroom, we shall almost invariably find more care, finish, and good work put into gold than vulcanite pieces. Gold work is much more difficult to master than vulcanite. A good gold workman easily learns to do rubber work decently; whereas a workman who got on tolerably with vulcanite might never make a good gold worker at all. Then let the pupil in the workroom throw his whole mind into his work whenever he is given a gold piece to make. Not working blindly and frantically, making continual mistakes and spoiling many pieces; although this way of getting on after a good deal of experience may finally make him a passable workman; I have noticed, however, that one who learns in this way only reaches a point of excellence sufficient to make life endurable to him, there he stops

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and can never be moved a jot further. But let the pupil when he fails carefully consider where and why he fails; whenever he has found out a real cause of failure he may be sure that, that knowledge will be useful to him not only in enabling him to avoid failure for the future, but by showing him the means by which he can produce the reverse results when these would be useful. If he is not able to produce this reverse effect when he wishes, he may be sure he has not yet found out the true cause of his first failure, and should seek further. What he sees in his workroom, the methods he is taught, should enter into his mind and be completely decomposed and digested before he begins to reproduce them in his own work.

In each detail let him think of the purpose for which it was done, and as it were re-invent the whole process himself afresh. This will give ample scope to his inventive faculties for the present, and when he is quite master of the work as it is done in the workroom in which he is being educated, with the reasons for it, it will probably occur to him that as some of these methods are better than those in vogue thirty years ago, there may yet be in the future better methods than these, and he will try to suggest an improvement. A real improvement, however, has many bearings. So many practical details have to be overcome, that many an idea which is very good in theory is found to be perfectly worthless in practice. Each detail in the work has to harmonise with many other details, so that many a new plan, which seems good and advantageous, has to be abandoned because on the whole it does not work well with the rest of the methods with which it has to fit. Hence it is, that an old workman has often to discourage those he is instructing, by assuring them that some plan which they have brought forward as an advance, is quite old, and has been entirely done away with by the very method which they now bring it forward to supersede.

The first thing to be done before beginning a gold plate is, to make a pattern in lead foil the exact size which it is

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intended the gold shall cover. Except in a few special cases to be hereafter mentioned, it should be cut out with the intention of only covering the mucal base, and not allowed to run up the necks or lingual surfaces of the teeth at all. It makes very pretty looking work to allow the plate to run some way up the necks of the natural incisors if these are standing, the gold being neatly chased around them; but I cannot find any other reason in its favour, and there are several against it. From the yielding nature of the mucal base, which is not represented by the plaster model and metal dies, a plate which has been struck up in this manner almost always presses on the necks of the teeth which have been covered, and the gold must either be filed back, running a risk of spoiling its appearance altogether, or the teeth will be protruded until the plate rests on the gum, the patient will feel as if his teeth were in a vice, and in some cases decay will be set up as if the teeth had been all clasped. On the other hand, if the plate comes irregularly close to the teeth without rising at all at their necks, the gum is apt to be irritated and pressed up between the plate and the tooth. It is therefore well for the plate to come close up to the necks of any teeth it may have to pass, and rest upon them just sufficiently to turn the edge of the gold up towards the tooth. This can be filed back a little to the mouth if necessary, so that the gold does not rest upon the teeth, and yet covers the gum snugly right up to their necks; or the gold may pass at some distance from the teeth either regularly or irregularly according to circumstances. For the same reason I think it better not to allow the lingual surface of such teeth as are to be clasped, to be covered by the pattern with the intention that the inner portion of the clasps shall be formed by the gold of the plate; let the plate come up just to the neck of the tooth, and put up the whole of the clasp with a fresh piece.

It may be objected to this, that if the reason alleged against striking up part of the plate over the lingual surfaces of teeth, namely, that the relative powers of resistance

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to the pressure of the plate, in the teeth and mucal base, are not represented on the working models, were the correct one, the same objection would hold good in vulcanite pieces which have been packed on the model to cover the lingual surfaces of the teeth. I feel the objection to be a strong one, but would say in reply that vulcanite is more yielding than gold and probably gives a little to the teeth, something also must no doubt be allowed for the slight indentation which the gold makes upon the zinc, and also for the fact that the teeth being the weakest parts of the casts, may give slightly. Whether one or all of these reasons together are the real cause, I am satisfied that more difficulties arise in fitting plates so struck, than can be explained by bad workmanship; and in corroboration of this opinion I have noticed that gold plates struck over the lingual surfaces of teeth, and chased around the necks, have generally been associated with work in other respects showy rather than sound.

Harris seems to think that it is the best plan to take a plain piece of plate of sufficient size and gradually work it down upon the model. I was educated upon this plan, but have found an accurate pattern decidedly advantageous. A plain surface, such as one side of a piece of note paper, may be bent and doubled into many irregularities without that surface being increased or altered in any other way; but it cannot be made to fit any complete concavity or convexity, as well as many other irregular shapes which have to be fitted by the gold plates. It is evident, then, that a gold plate before it is got to fit these surfaces must really undergo some amount of plastic change. Some parts will be stretched to go over convexities or into concavities whilst the margins of these parts of the plates will be compressed, the particles being thrust closer together so as to thicken it. It is the resistance which the cohesive force of the particles of the plate offers to this change of place which constitutes one of the principal hindrances to be overcome in breaking down a plate. All the gold which is not required in the finished plate, and which would lie around its margin, is therefore

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worse than useless, increasing greatly by its presence the difficulty of the work.

Another reason in favour of an accurate pattern is, that the hinder margin of the plate can be much more perfectly bevelled when the plate is flat than at any other time. This not only gives the plate a better finish, but if it covers many small irregularities, actually strikes up closer and fits more snugly in consequence. This bevelling of the posterior margin of the plate before striking, however, must not be done in a mouth with a deep concavity in the palate, or it is apt to pucker.

To cut out a good pattern in lead foil is then the first thing to be done, and merits a little attention. Take a piece of lead foil rather larger than is necessary, and press it down with the fingers into the palate, rubbing it first in the central line up to the necks of any teeth which may be standing, but no further, and then up to the necks of the masticating teeth; now mark and cut out the posterior margin of the pattern: proceed to mark around the necks of such of the teeth as are contiguous, and cut out the line, leaving it a little high here to allow of slight errors in getting the plate down. Now make a little hole in the lead exactly in the centre of the lingual surface of the neck of all the isolated teeth, which the pattern passes, at the place where the gum meets the tooth, and with the scissors cut a straight slit from this through to the margin of the pattern. The tongues and parts which cover the alveolar ridges are now to be gradually worked down into place with a blunt smooth tool, cutting away all superfluous portions as soon as recognised. After trimming carefully, the pattern will be found to have some creases and some parts stretched, these must not be altered in flattening it out: in doing this, care must be taken to preserve as well as possible the general spread of the piece. The gold plate is now cut out by the pattern: if there are any sharp indented angles it is better to punch a hole here with the punching pliers before cutting it with the shears, as this will much lessen its tendency to run

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into a crack in striking up. If the concavity of the model is not deep, chamfer the posterior margin of the plate by filing it, bevel for an eighth of an inch. Take out the marks of the file with No. O glass paper wrapped round the file, and finish the edge by rubbing it longitudinally with the glass paper on the finger or thumb until it feels perfectly smooth to the uncovered finger. This will give you a better edge than you can get afterwards in any way.

If it is a partial upper proceed to get it into place by first striking down those parts which cover the outsides of the ridge, including isolated tongues, on the first zinc cast. Each tongue or saddle being independently struck into place with hammer and mallet, after which the plate may be slightly malleted down on the palate and in its general bearings until the saddles and tongues come nearly over the right positions.

The plate may now be placed between the two metal dies on the anvil or striking slab, and receive a slight blow from the striking hammer to settle it in its place. It should now be looked at to see if it is going right, and if not the position of the plate readjusted. In consequence of there always being a great deal more plate on the palatal side of the alveolar ridge than on the other the draft of the striking has a general tendency, before the plate is well settled in its place, to draw it backwards; in order to counteract this it is well to keep the plate well forward at first. If all is going well a few more blows may be given and the plate looked at again. It will now be sufficiently in place to allow of any superfluous plate being filed or cut away. Should the posterior tuberosities be strongly developed, and to be covered, the plate will probably pucker at the back of them; to obviate this it is well to cut a slit with the shears, chamfer the two edges thus formed, overlap them sufficiently to obliterate the pucker, and solder the overlap with No. 1 solder, when the striking of the plate can be proceeded with.

Contrary to what might have been anticipated an entire upper plate is more difficult to strike up than a partial one.

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This is, no doubt, owing to the fact that its shape offers more resistance to those stretchings, and compressions, which its various parts have to undergo in order to fit the various convexities and concavities of the model, whilst at the same time it has more of these to cover uninterruptedly. Where the plate covers the anterior part of the alveolar ridge will usually be found, except in very flat or broadly rounded ridges, a considerable pucker as the plate is being struck down. To obliterate this make a slit and overlap in the median line, as described for the posterior tuberosities or two such slits may be made if the model shows a very broad or square arch, one at the position of each canine. When the concavity of the palate covered by the plate is deep or considerably scooped, it is evident that the gold will be very much stretched before it can fit correctly, and the tension which this will throw upon the other parts of the plate will have a great tendency to give the plate a rock or spring, which it will be difficult to eradicate. To meet this difficulty, it is well to anticipate it by beating the gold thin with a hammer over the part which will cover the concavity, on some rounded piece of iron. There is usually a blacksmith's vice in the workroom, the handle of which is terminated by round knobs. One of these will serve very well; or the end of a rod of steel may be filed round about the size and shape of the small end of a hen's egg, and fixed in the vice for the purpose. The plate while still flat is to be held over this and struck with a hammer, so that the gold is thinned between the hammer and the steel or iron. No attempt is to be made to hammer the gold down over the round steel; beginning in the middle of where the concavity is to be, the gold is to be moved about concentrically whilst the blows are continued, so as gradually to thin the gold over the whole of what is to be the concavity in the plate, not, however, extending the blows to the edge of the plate, and thinning the gold gradually less as it approaches the margin. In consequence of the gold being thinner it covers more surface, and the margins not being

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extended, takes a concave shape, of which the concavity will be on the side opposite to the face of the hammer. A plate, after having been thus prepared, will, when annealed, strike up very much more easily than if this precaution is omitted.

Three zinc dies or casts, and three lead counter dies or hollow casts, are the orthodox number for ordinary cases. Each cast has a distinct function to perform, so that if the number of these is increased or diminished, it must be because one or more of these departments requires more work in it, or does not require any. The first cast is to break the plate down, and also to do some of the work of the second cast. The second cast is to develop the rugæ and other minor irregularities, and do some of the work of the third. The third cast is to give the general spread, and eradicate any rock or general misfit which the plate may have acquired.

For a small plate which can hardly be said to have a general spread, the third cast may sometimes be omitted; whilst for an old plate which has to be re-struck, the first cast is not wanted. For casts having very deep rugæ or other secondary irregularities, two casts to perform the office of the second may be necessary, whilst some plain uppers may require two casts after their irregularities are sufficiently developed, in order to get a steady fit on the model.

In order to facilitate the breaking down of the plate on the first cast in partial cases, it is usual to saw or file off the teeth of the zinc nearly level with the gums, and imbed the cast in sand, so that only the part to be covered by the plate is exposed before pouring the lead on it to make the counter die, which in this case is called an upside down or shallow lead.

An anvil fixed upon a bulk of wood is convenient for striking on; but in default of this a slab of hard wood, such as ash or oak, two inches thick by six broad and eighteen long, will answer perfectly well. A piece of sheepskin rolled up with the wool inside so as to form a cushion, should be laid upon the knees first, then the slab of wood, and upon

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this the workman can get up any plate. The hammer, which should be from eight to ten pounds weight, should be raised for each blow perpendicularly above the cast to the full length of the workman's arm, and allowed to fall with a steady, straight blow, and not swung back over the shoulder.

In ordinary cases I used to find that it took about two dozen blows on the first cast, three dozen on the second, and from half a dozen to a dozen on the third, with a ten pound hammer to get up a plate satisfactorily.

Where there are isolated teeth leaning towards each other making a model difficult to cast, a slight amount of waxing may be allowed; although it is astonishing how much may be achieved by a little perseverance, and studying the best directions in which to coax a model out of the sand. It is almost hopeless, however, now to expect the expert casting which was necessary when lower cases as well as all uppers were made in gold, and the following expedient which I had from Mr. J. Keys will sometimes be found advantageous:— Use strong shawl pins for strengthening the teeth of the model, then with a piercing saw cut the obstructive tooth or teeth nearly off the plaster model, a little twist will break the rest, when it, together with the supporting pin, can be withdrawn and the cast made; the tooth can then be refixed in its place with a little glue or cement.

In getting up a plain upper the pupil is often disgusted to find that, having got the plate almost to a dead fit before he had half done the second cast, the more he strikes it afterwards the worse apparently does it become. The first fit, however, is quite deceptive, and is caused by the plate resting on a few points of the model only, the intermediate parts being untouched, as the plate comes more intimately in contact with all parts of the cast the real difficulty of getting a dead fit becomes apparent.

If the plate be tried on the model when the second cast is nearly finished, there will usually be found a considerable rock from behind forwards, and if the model be examined it will be found a little rubbed or polished along the external

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margin of the alveolar ridge showing that the plate rested there. This is no doubt owing partly to the fact that the zinc cast has slightly contracted, and partly that this part being more prominent has been slightly beaten down in striking against the gold plate. If the posterior tuberosities are bulbous so as to make a hollow in the external face of the alveolar ridge just anterior to them, the plate usually dips into this hollow so as to make a stiff and obstinate rock. If the model is irregular in shape and has strongly pronounced irregularities it may rock over these, but any rock where a convexity of the plate is towards the cast on one side of the saddle of the ridge is more difficult to eradicate satisfactorily than any other.

Stiff brown paper in two, three, or four thicknesses should be put wherever there is a rock between the plate and the zinc, and the plate struck until it drops upon the model quite loosely.

It should now be pickled in acid and well annealed, and is then to be placed on the third cast to receive three or four steady blows. These must be quite true upon the zinc, and not tilting in any way. In order to do this a suggestion given by "Harris" is very useful, who recommends that a small round piece of iron with a handle should be held on the middle of the zinc to receive the blow and distribute the force from the centre.

A worn-out nut of an old vulcaniser will answer the purpose, with a piece of stout iron wire twisted round the middle, and then standing off for a foot to act as a handle, but if this plan, which is certainly good, is used, the casts must be very deep, or it will split them almost immediately. The plate is now to be tried on the model again, and if satisfactory should not be struck again; usually, however, the spread will be found either too much or too little, that is, the plate either rocks on the middle of the palate, or the palate does not go quite down without a little pressure, the plate resting on the lingual lateral sides of the ridge. In either case it may be strained a little too much in the

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opposite direction by hand, so as to bend it rather more than sufficient to correct the defect, after this it is to go on the cast and receive one or two more blows, and this process must be repeated until a satisfastory fit is obtained. If many more than a dozen blows on the third cast are required to get the plate right, it is necessary to use another with a fresh lead. Finishing off the striking requires a good deal of delicacy to know when to stop; sometimes a happy result can be obtained by turning the casts over and giving the lead a blow or two, or by placing a single layer of brown paper between the plate and zinc, or by using a tin cast to finish with.

As soon as the plate begins to clap, that is, if when held down at one end it springs up at the other a little, which it will usually do, and this loose end if rapped with the knuckle strikes the model below with a clapping sound, it is not far from being right, as the clapping sound is produced by the whole surface of the plate striking the model suddenly, which it will not do if there is much bind, or rock, or false seat about it.

A plate may be bent by the hand or otherwise as much as the workman likes, so long as it receives a fair blow on the cast afterwards; but no workman should be allowed to bend a plate after it has finished with the casts.

The plate having been passed as fitting, the workman is now responsible until it goes out of hand, that the fit is unimpaired.

A greal deal is said in the American handbooks about the plates warping in soldering, and with their methods of putting up flat teeth all round the ridge there may be such a danger; but in English work with isolated soldering, I am satisfied that a warped plate means a heavily handled plate. Shears should never be used to a plate after it is struck up. Plate cutting pliers (Ash's Catalogue, p. 226, 55), will not strain a plate if used in the following manner:—Place the small blade of the pliers on the concave side of the plate and hold the plate very loosely in the hand, almost letting it

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go at the moment of closing the handles of the tool; in the same manner holes may be safely punched for pins with the perforating pliers (Ash's Catalogue, p. 225, 52), so long as nothing but the opposing points of the pliers touch the plate, the perforating pin being always on the hollow side of the plate, unless the concavity is large, when it hardly matters; but the plate must be held very loosely or it may get a strain. When any part of the plate has to be filed or sculpered, the plate should be held as close as possible to the part operated on, which should also receive the immediate support of the bench pin, the rest of the plate being quite free of the hand. If the whole of the plate is grasped by the hand, unconscious pressure is apt to give it a strain.

In partial uppers the same continuous care must be exercised after the plate is finished striking, to maintain the integrity of its fit whilst putting up the bands. Careful patterns in lead foil should be made for these, and suitable gold cut out to correspond. Each band should be bent to fit the tooth, beginning at the end, which will be soldered to the plate; or, if both ends are free, beginning with that end which will be shortest, and bending with the pliers a little at a time, fit neatly the whole of the tooth contiguous to the plate. If the tooth to be fitted is short and convex, a corresponding concavity may be advantageously made in the band before bending it by striking it with a round-headed punch on a piece of lead, or in the manner described previously for making a concavity in the plate. After a good many trials I have not found any advantage from striking up bands on the casts; from the nature of the case they cannot be fairly struck up, usually striking awry, and in those cases which have looked the most successful on the model in the mouth, they have been productive of much trouble in fitting, giving rocks or springing the plate down in consequence of pressing too much on the sloping coronal part of the side of the tooth.

The band having been fitted to that part of the tooth on the model which is contiguous to the plate, the rest may be

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left open to allow of its more easy removal when cemented to the plate previous to soldering. The plate is now to be filed back until it goes quite down into its place without resting upon the band at all, but just coming up to it. Plate and band can now be securely cemented together in the following manner:—Heat the plate and rub on its upper surface around the place for the band a stick of the cement sold by Messrs. Ash for the purpose; a little will melt and stick there: do the same with the clasp, and if any runs inside scrape it away before putting on the model. Replace clasp and plate on the model and run more of the cement, so as to hold them together, with a hot modelling tool, using plenty of the cement; when cold, the two must be carefully removed from the model, taking care that their relative positions are not changed, and packed in casting sand for soldering as previously described. One other precaution may be mentioned: the acid pot should be kept pretty full, as a plate has ere now been bent by being thrown carelessly in at red heat, when there has been little fluid in the pot, so that one end of the plate has struck the bottom before the whole of the plate has been cooled by being immersed.

If the preceding precautions are rigorously attended to, from the time the plate leaves the casts to the time it leaves the workroom, I believe very little complaint of warping from soldering or annealing will require to be made.

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CHAPTER VIII.

SMALL GOLD UPPERS.

Cases occur in which a single central has been lost, leaving an otherwise uninterrupted dental arch. These are, perhaps, most simply treated by fitting a tooth to the mouth first and then packing it on the model with vulcanite; in the lower carrying two wings back inside and up to the top of the teeth as far back as the molars. If the teeth are at all undercut so that these wings would be likely to sink downwards, put a gold strengthener into the piece and solder in it at right angles two little wire stops or rests, which can be bent over so as to rest on the masticating surface of either the molar or second bicuspid. If it is wished to have bands so as to tighten the piece, although rarely necessary, these should not be placed around the incisors, being unsightly and detrimental to these slender teeth, but can be added in the same way as the stops, letting the wire be rather stouter, carrying it over the row of teeth between the bicuspids, or molar and bicuspid, down to the gum on the outside, and then at right angles again and forward so as to clasp the second bicuspid at the margin of the gum; or, what is better, a small piece of plate bent to fit portions of the necks of both molar and bicuspid can be soldered on to the wire as a T-piece. See fig. 43 *a*, *a*.

For uppers, where the bite is not close, a vulcanite plate often answers very well, and should be made of a thin layer, carried back as far as the distal side of the second bicuspid

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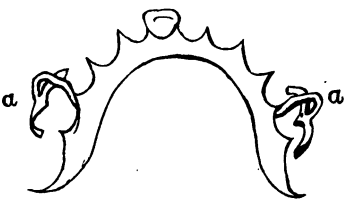
and then giving the posterior margin of the plate a curve towards the throat in the contrary direction to the arch of

FIG. 43.



Design for vulcanite piece to replace lower central incisor with an otherwise unbroken Dental arch. *a, a.* Gold clasps embracing necks of bicuspids, connected by a wire with the vulcanite.

the teeth, so that the general outline of the piece will be circular or oval. These pieces should have been described under the head of vulcanite pieces, only that the class of cases most similar being usually made in gold caused me to overlook them.

The following case will pretty well illustrate another class of small pieces :—Miss C— had lost the right upper central and left lateral, together with all the masticating teeth, so that she was reduced to do all her eating with the few front teeth left, in consequence of which these were considerably forced forward, rather loose, and the canines divergent. From motives of economy she desired to have only the missing front teeth restored, so as to do without a large piece as long as she could. A small gold piece was therefore made, but in order to prevent its being loose in the mouth it was struck up of thin plate (No. 6, plate gauge), so as to cover and rest upon a considerable portion of the lingual surfaces of the teeth, instead of resting only on the mucous membrane. The canines were clasped by fine wire, which, instead of going round the neck of the tooth on its distal surface, was carried here up to the angle of the posterior protuberance, then down again to the gum, and

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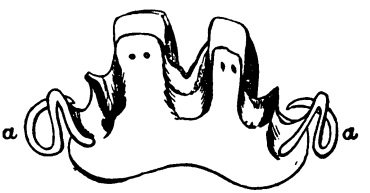
forward round the neck of the tooth at the gum. This loop enabled the clasp to hug the tooth snugly, and yet was sufficiently elastic to allow the plate to go into its place and the clasps to pass over the diverging canines without much difficulty (see fig. 44).

FIG. 44.



Design for small piece where the canines to be clasped are long and divergent. The wires, *a*, *a*, being bent up to the distal protuberance of the canines and then down to the gum again before bringing them round the neck of the tooth, give a very elastic and clinging clasp, and the plate being struck high on the lingual surfaces of the standing teeth, gives greater steadiness to the piece.

Two flat backs were soldered on after the plate was tried in; and the piece was worn for four years, when the left central falling out and the other teeth being very loose these were removed and a suction upper substituted.

When one or two of the upper incisors are to be replaced, there being no other break in the dental arch, a gold plate will be indicated, if the bite of the lower incisors comes so close to the gum as not to allow of a sufficient thickness of vulcanite to carry the teeth, or if the bite is close, so that flat backs are necessary; if the natural teeth are very short or the palate very flat, so that vulcanite would unduly fill up the mouth.

Three methods of making such a piece are in current use:

The first, and the one that is the simplest and has least merit, is to cut the pattern for a very small plate only, extending from behind one tooth on each side of the vacancies, and bringing fine wire points around to the front of the

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teeth on each side of the gaps, keeping these points as fine, short, and close to the gum as possible to prevent them from showing, and recommending the patient to keep them covered with floss silk. This advice, although it relieves the Dentist of responsibility, is, however, seldom acted upon for long, and the fine wire is generally eventually detrimental to the sustaining teeth.

The second method is to carry the plate on each side back beyond the second bicuspid, soldering on stays to embrace closely the lingual surfaces and necks of the bicuspids, having their free ends sharp and long, so as to run in between the teeth in the spaces close to their necks. This method is open to the same objection that the stays are more or less detrimental to the embraced teeth, although not to such an extent as the fine wires of the first described plan.

The third method, which is perhaps the best, is to make a small, light suction piece, which, however, will require more care.

The following case will serve as an illustration:

Mrs. W— had lost the right upper central and left lateral. Her teeth were long, but the lower teeth almost touched the gum at the back of the incisors when the mouth was shut. She had worn a small gold upper, which was stayed against the bicuspids, but these teeth had become very sensitive around the necks from the pressure. To this they were perhaps predisposed from the fact of her being in a state of great pulmonary delicacy, if not in actual decline.

Under these circumstances it was determined to make her a small suction upper. To do this two conditions have to be met. A certain surface is to be covered to exclude the air, and the gold must have a sufficient strength to carry the teeth. To meet the first condition the thinner the gold the better, as thin plate is capable of being more accurately and sharply fitted than thick, and it is also much lighter. To carry single teeth, however, gold ought seldom to be less than No. 7 (plate gauge) in thickness; it is evidently advantageous, therefore, to carry out these condi-

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tions separately. Make the suction part of the plate of very thin gold, and a skeleton piece of thicker to carry the teeth, and then solder the two together.

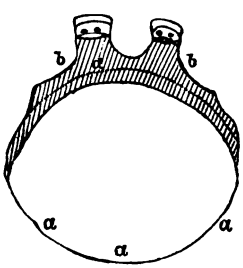
This was done in Mrs. W—'s case in the following manner:—Some old gold springs were melted up, and a small piece of plate rolled to No. 5, plate gauge, thickness; this was used in preference to ordinary plate as being the stiffest gold obtainable, and, therefore, capable of being used thinner than any other.

A pattern was cut so as to come up to within a sixteenth of an inch of the necks of all the front teeth, as far back as the second bicuspids, and then curve backwards towards the throat, so that it made a nearly circular shape.

Another pattern was cut out of ordinary eighteen plate, No. 8 thickness, so as to give two connected tongues to carry the teeth with the internal distal angles extended into two fine horns, so as to run back and cover the dental margin of the suction piece, in order to give the piece strength.

The two pieces were struck up separately and together, and then soldered together (see Fig. 45).

FIG. 45.



Outline of Mrs. W—'s small suction gold upper. *a, a, a.* Suction disc of thin gold. *b, b.* Small piece of thick gold plate to carry the teeth, slightly overlapping and soldered on to *a*. On the under side of *a, a, a,* is a fine wire encircling the plate at a sixteenth of an inch from the margin to increase its powers of suction.

In order to make certain that there should be no leakage

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of air under the plate, and to act, perhaps, beneficially as a spur, a very fine gold wire was soldered on the under surface surrounding the whole of the suction piece at a sixteenth of an inch within the margin. For this purpose the wire of an old spring was straightened and used; one end being held in place by clamps, a small piece was soldered at a time, and then the clamps shifted and some more soldered, and so on until the ends met again, using very small pieces of No. 3 solder. The plate was then tried in the mouth with the teeth on cement in the usual manner, and after they were fixed by soldering was worn with success.

I have not had a great many of these cases, but all I have made have been so satisfactory that I think the method deserving of attention.

I never remember to have made a piece for a single masticating tooth, although I have seen a few such pieces, the disfigurement caused by the loss of even a first bicuspid is so slight that the Dentist will best study the welfare and comfort of his patient by recommending him to put up with its absence. The same advice would be tendered in the case of the want of two bicuspids only. Where a canine and the adjoining bicuspid are to be supplied, a pattern would be cut to go inside from the mesial side of the lateral on the same side to the distal side of the first molar.

No 6 tight, gauge plate, size would be used, and a wire brought round the outside of the second bicuspid at the neck, and a very fine point of wire placed so as to touch the lateral on its external distal surface close to the gum, to be dispensed with, if possible, after the piece is tried in. If it is wished to make a piece for two adjoining bicuspids, a similar pattern should be cut, only carrying it behind the second molar.

For the first bicuspid and first molar on the same side, the pattern should go from in front of the canine to behind the second molar, and it is best to clasp the second

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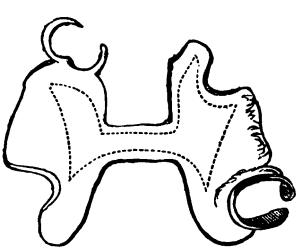
bicuspid only, letting the grip of the band be antero-posteriorly if the tooth is stout in the neck and tolerably long, but bringing the band or wire outside if the tooth is short or with a small neck.

All of these little pieces for less than three masticating teeth are, however, in my opinion, excusably avoided. But when there is room for two such small plates by vacancies on both sides of the mouth, the want of the masticating function will amply justify us in proceeding to supply the deficiencies.

In such a case it will evidently give greater firmness, entailing fewer clasps, if we connect the pieces, and the question will then present itself, whether this should be done by continuing the plate around close behind the front teeth or joining the two by a piece of plate passing across the roof of the palate, so as to make a plate in shape something like the letter H.

If the front teeth are at all delicate, so that an addition to supply the loss of one of these at no very distant date seems probable, the first method will be chosen, but if these teeth are all strong and healthy, we shall make a piece more agreeable to the patient if we pursue the second course; by this means the *rugæ* of the palate opposite the tip of the tongue are left uncovered, much to the gratitude of that member.

FIG. 46.



Design of plate for Col. K—. Plate No. 6 thickness. The dotted line indicates the strengthener, No. 8 thickness.

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Such a plate will require the isthmus to be doubled. This can be done in two ways, either by cutting out the whole pattern in thin plate, No 7 loose, and then cutting out a smaller piece as a strengthener (see Fig. 46), or by cutting out two patterns, leaving a tongue on one to lap over that of the other (see Fig. 47).

FIG. 47.

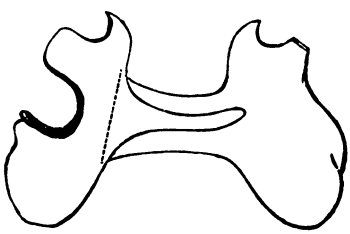

Plate made in two pieces, No. 7 thickness, cut so as to overlap each other.

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CHAPTER IX.

SUCTION GOLD UPPERS.

A GOLD upper-piece has many advantages over a vulcanite one; it is much thinner, and therefore interferes less with the function of speech in talking, singing, &c. For this reason we shall often be desirous of adapting it to the mouths of young persons who feel it a sort of degradation to have these faculties in any way impaired. It is indicated as well for those whose professional avocations make special calls upon the vocal powers, such as public singers, lawyers, clergymen, &c. Wealthy patients also often have a strong prejudice in favour of gold, which there is no reason to discourage, except the limit which is placed by our capacity to make the denture of real benefit to the patient. For as vulcanite is much more easy than gold to work, so as to make a good fit, it is evident that under the same conditions, as to the capability of the workman, a much better fit will be produced of any piece in vulcanite than gold. Where extreme accuracy of fit, then, is of great importance, we shall generally find vulcanite superseding gold work. In suction pieces this is pre-eminently the case, and, as a consequence, we find that the great majority of suction pieces are made of this material. It is therefore desirable to know, as without doubt some mouths are very much easier to fit with suction pieces than others, what are those conditions which make it so easy to supply a suction piece, that the advantage which fit generally gives to vulcanite does not counter-balance the advantages of gold as previously mentioned. One condition which should never

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be lost sight of, consists in the habits of the patient, whether he has worn a piece before, and how he manages it; for one patient will retain with perfect comfort and satisfaction a piece which another will not wear for an hour. The state of the mucous membrane is another consideration, that of a medium and even consistence in a tolerably moist mouth being best; a very hard, dry, bony gum being very difficult to get much suction upon; and although a soft, spongy gum gives very good suction to a direct pull, yet from the unsteadiness of support which it gives to the bite in eating, it is often troublesome in results. The actual shape of the mouth is, however, the main consideration, and of the many conditions which are involved in the differences we meet with. That shape which gives the fullest support to the bite, other things being not very unequal, will be the easiest to succeed with.

Edentulous upper jaws may be roughly classified into those where the curve of the alveolar ridge is—

1st. Semi-elliptical, with a scoop-shaped concavity in the palate. This is, in my experience, the most common.

2ndly. Like a Roman arch, round in front with parallel sides, the bottom of the palatal concavity being often flat.

3rdly. Semicircular, with a semiglobular concavity.

4thly. Like a gothic arch, the concavity of the palate having a section like the letter V, often terminating in a mere crevice.

5thly. Mouths which have originally had either of the foregoing shapes, but which have become quite or almost flat from senile or premature absorption of the alveolar processes.

Whether there is any connection between the long-arched mouths and long-headed races, or the short-arched mouths and the round-headed races, it would no doubt be interesting to ethnologists to know and may be worth observation.

Of the different types enumerated the following have been found easy and difficult cases respectively:

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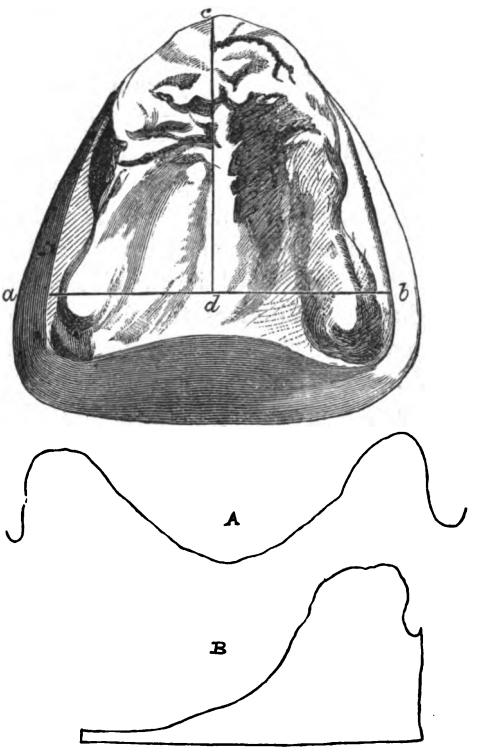
Mr. B— (Fig. 48) presented one of the first class of mouths—the semi-elliptic—but rather inclining to the

Fig. 48.



Mr. B—'s model, good shape for suction-case, but result unsatisfactory in consequence of yielding nature of ridge.

A. Section of model through *a*, *b*.

B. Section of model through *c*, *d*.

In Figs. 48 to 54 inclusive sections were made by sawing the models through at the line indicated and then outlining on paper.

second or Roman arched. The alveolar ridge was developed with prominent posterior tuberosities and a well-formed scoop-shaped concavity in the palate. A vulcanite piece was made upon a tin cast, but although the fit was good,

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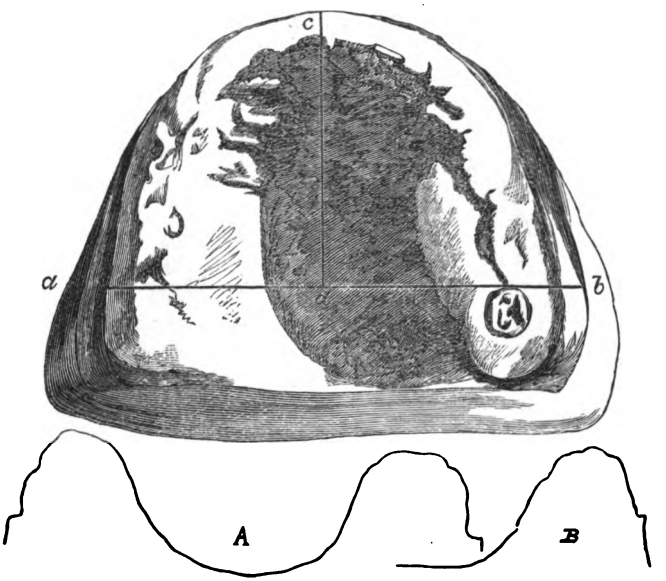
giving good suction to a direct pull, the result was not very satisfactory, coming down in talking and playing the flute, and tilting in eating, in consequence of the exceedingly yielding nature of the alveolar ridge. This yielded to the finger in any direction, as if all the bony tissue were absorbed and its place supplied by fibrous tissue.

Miss M— (Fig. 49). This lady presented a well-formed

FIG. 49.



Miss M—y's model. Good case for suction. Ordinary gold upper with teeth set to the gum in front worn without difficulty.

A. Section through *a*, *b*.

B. Section through *c*, *d*.

mouth of the third variety, that with the semi-circular arch. The teeth had to be very short in this case from the slight absorption of the alveolar process, and had to fit the gum in front. The patient being a nervous invalid it was judged wise to adapt springs, and a No. 8 thickness gold plate was struck up in the usual manner, without any particular care

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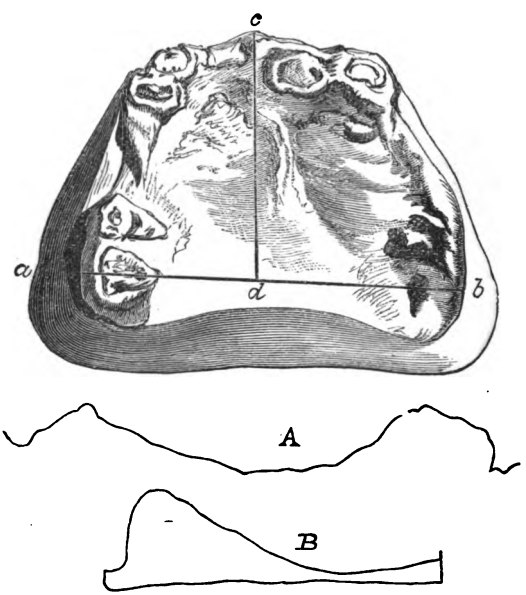
being given to it. The plate was tried in the mouth, and the teeth mounted in wax in this position, and afterwards attached to the plate by vulcanite. After wearing a short time, however, it was found that springs were quite unnecessary, and they were discarded, and although the suction is exceedingly slight it has no tendency to displacement in wear.

Miss M— (Fig 50) had a nearly flat mouth of the semi-

FIG. 50.



Miss M—'s model. Vulcanite suction upper; very successful; gave no trouble.

A. Section through *a*, *b*, reversed.

B. Section through *c*, *d*.

circular type, which, however, retained several tolerably firm and healthy stumps. The support which these were expected to give the bite, which was comfortably within the ridge, justified the anticipation that a suction piece would succeed,

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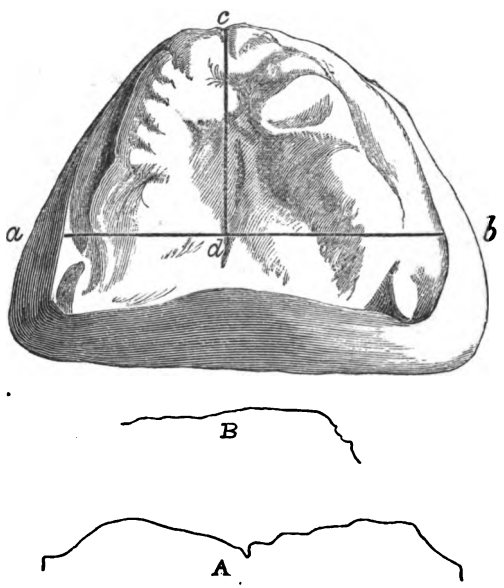
which it did in an eminent degree, never coming down or tilting, and requiring no alteration after the first visit whatever. It was made in vulcanite on a tin model.

The Rev. F. B— (Fig. 51) had a small flat upper, the

FIG. 51.



The Rev. F. B—'s model. An exceedingly difficult case, the ridge being small and yielding, and nausea preventing a deep plate.
A. Section through *a*, *b*.
B. Section through *c*, *d*.

gum representing the alveolar ridge, being very soft and flabby. The bite was outside the ridge, and all attempts at making a suction case utterly failed. In consequence of the nausea which it produced the patient could only wear a narrow plate, and it was with considerable difficulty that any measure of success was attained when wearing strong springs.

Mrs. P— (Fig. 52). Presented the gothic arched variety of mouth, with full gums, some healthy stumps being retained, and the bite being well on the top of ridge. The

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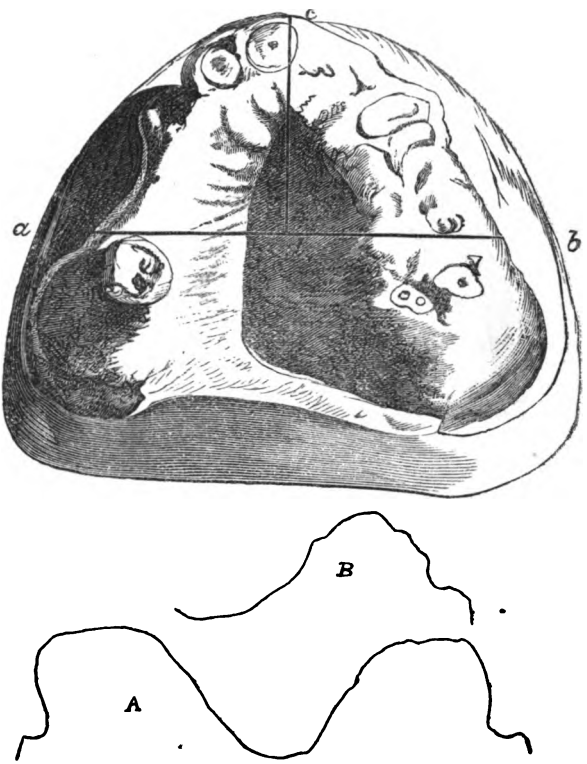
teeth very short. A gold piece was adapted which received slight support from a clasp embracing the right upper molar.

FIG. 52.



Mrs. P—p's. A good shape for suction upper; wore gold uppers without difficulty.

A. Section through *a*, *b*.

B. Section through *c*, *d*.

A deep plate was not found necessary, and no trouble was experienced. This lady had a duplicate which was equally easily successful.

Dr R— (Fig. 53). Presented the gothic arch, but with the ridge considerably absorbed. The bite was outside the ridge, and it was found impossible to get him to wear a

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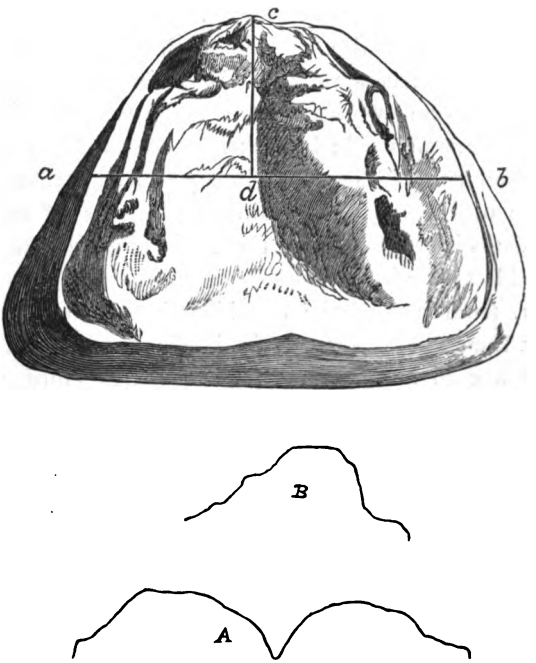
suction, although to a direct pull the suction was excellent; but on attempting to eat or smoke the piece tilted at once,

FIG. 53.



Dr. R—'s model. Bite outside ridge. Failed as a suction case; gold plate made with strong springs.

A. Section through *a*, *b*.

B. Section through *c*, *d*.

and came down. A gold piece was made, and strong springs (No. 10) were found necessary to keep it steady.

In the selection which has been made, it will be noticed that the three good cases cited, Miss M—y's (Fig. 49), Miss M—'s (Fig. 50), and Mrs. P—p's (Fig. 52), vary in almost every particular of shape, but agree in the fact that the bite was well supported. Whilst the three bad cases, Mr. B—'s (Fig. 48), the Rev. F. B—'s (Fig. 51), and Dr. R—'s (Fig.

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53), differ though not to so great a degree in general characteristics, but all agree in having a greater or less degree of deficiency in the conformation which yields steady support to the bite. The Rev. F. B—'s, which was the worst of all, being most deficient in this respect.

In the unsuccessful cases as much greater efforts were made to attain success than in the satisfactory ones by the same operators and workmen, and the result in the different cases were very marked; I think that they forcibly illustrate a conclusion which we have previously arrived at theoretically. That one of the most determining elements of success in suction cases is the nature of the support which the alveolar ridge yields to the bite.

When, from any of the considerations which have been urged at the commencement of this chapter, it is determined to make a gold suction piece, a great deal more care and attention is necessary at each step of the proceedings than for ordinary gold work which is retained by clasps or springs, or for making a vulcanite suction piece, as the following case will testify: Mr. M—e presented a fairly good mouth of the semi-elliptic type, bite slightly over the ridge, and rather high. Being a wealthy man, and anxious to have the best without regard to expense, it was determined to make a gold plate.

A plaster impression was taken of the mouth, a plate struck up and tried in, an accurate bite obtained, and sectional gum blocks mounted. The piece promised fairly, the suction being excellent to a direct pull, but after trying persistently for several weeks it was pronounced a failure. A fresh impression in plaster was taken with the intention of restriking the plate and resetting the teeth, and an appointment was made for a fresh trial of the plate; but having a good bite it was concluded to make a vulcanite piece as a trial, to give him something to use until the fresh piece was ready. This, however, was so decided an improvement that he was quite satisfied with it, and has worn it with comfort ever since.

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Accuracy of fit and lightness being two very important conditions for a suction piece, it will be advantageous to use gold as thin as possible, and to this end extra care should be paid to have the gold of good quality and tough. It is best to use 20-carat gold alloyed with twice as much copper as silver; in fact, when melting up sovereigns for this purpose add only copper. Use the gold No. 6, plate gauge thickness, and add a narrow strengthener, No. 8 or 9 thickness, so arranged as to stiffen the arch of the plate and hold the attachments of the teeth at the same time. The plate when ready should be tried in; and an extra cast and counter-sink having been kept for the purpose, it should be altered to the mouth, and reswaged until an accurate fit and some suction is obtained before proceeding to mount the teeth. It is not to be imagined that because it fits the plaster model success will be obtained, as often from the irregular consistency of the mouth a plate will rock there in a manner fatal to suction, which will not show this tendency on the model.

Miss S—. A rather nervous and sensitive young lady, a governess, who had a great deal of talking and singing to do, wanted all the teeth posterior to the canines in the upper jaw supplied. The stumps of the first bicuspids remained, and the bite, which was close upon these, and could not be raised, forbade the use of vulcanite. The shape of the mouth was very similar to that of Mr. B— (Fig. 48), with the exception of the retention of the front teeth and stumps. A plate of 20-carat gold, No. 6 thickness, was struck, and strengthened by a piece of No. 8 thickness, 18-carat gold. The pattern of thin gold being cut so as not to touch the front teeth at all, and going back to the soft palate behind; the strengthener was cut in the form of the letter H. The two wings lying on the top of the alveolar ridges, and the joining their middle across the deepest part of the palatal concavity. The plate when tried in rocked in the centre of the roof of the mouth. This was remedied by placing several thicknesses of hard brown paper at this place between the metal cast and the plate, and striking it until

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sufficient relief had been obtained. Flat back canines were mounted in the position of the first bicuspids with tube molars behind. The piece has been worn now several years with comfort.

Miss B— possessed dazzlingly white teeth, of which she was very proud, but unfortunately they were of such a fragile nature that it was impossible to arrest decay, and the back teeth went one by one until all those which supported a small gold upper she was wearing for the sake of a lateral were gone, and she was very anxious for something to be done without being driven to springs. As it was evident that the remaining front teeth would soon follow their neighbours, and an addition to a vulcanite piece always more or less impairs its value, a gold suction was determined upon. The mouth was of the semicircular type, fairly developed, and it was considered that the presence of the lateral between the natural teeth would help to give steadiness to the bite. A plate was made in very much the same way as for Miss S—, with the exception that the strengthener was carried close behind the front teeth, so as to give sufficient strength here to add a tongue of gold and fresh tooth when required. It was tried in the mouth and adjusted, as previously described, until a good fit was obtained, when tube teeth were mounted in the usual manner, and it has been worn for some years in comfort. Since it was put in the lady has married and had the lateral and canine of the other side added, without, she says, her husband being aware that she wears artificial teeth.

Some mouths have a hard, bony protuberance in the roof of the palate just anterior to the soft palate, almond shaped, sometimes cleft, sometimes simple; in these cases I have found the best practical method of obviating a rock, is to strike a thin piece of copper plate, No. 5 thickness, on this protuberance, between it and the plate in any gold plate, cutting it out as by the dotted line, Fig. 54, so as to rather more than cover the protuberance. The edges should be chamfered, and if one thickness is not sufficient it should be

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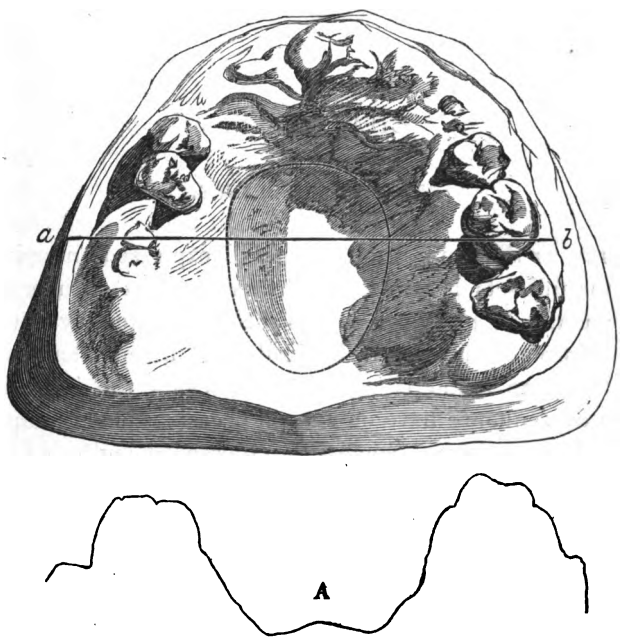
doubled, the second thickness being rather smaller and placed concentrically with the larger.

FIG. 54.



Model to show bony projection in palate.
A. Section through *a*, *b*.
Dotted line shows region where plate should be relieved.

Miss P— presented a mouth of the Roman-arch type, all the upper teeth being gone but one first bicuspid. In this case there was a bony palatal prominence as in Fig. 54, only that it was divided by a longitudinal indentation in the median line. The teeth being short and there not being much room in the mouth, a gold upper was made and fitted as described for the two previous cases, the strengthener lying over the alveolar ridge, the bicuspid not being clasped at all, two thicknesses of copper plate were required to relieve the rock. Tube teeth were mounted, and the piece has answered very well for several years.

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CHAPTER X.

SETS WITH SPRINGS.

When writing on vulcanite uppers I expressed an opinion that for full sets it was better to use springs with a gold upper plate. This position has been disputed by several brother professionals enthusiastically and independently. I have therefore found it necessary to review the judgment, and in consequence have on several occasions made complete sets without springs. Some have succeeded and some have required springs to be subsequently added. The principal difficulty is to keep the lower steady and unmoved by the actions of tongue and cheeks and adjacent loose parts. To meet this, one Dentist proposed loading the piece with lead, which may be done where there is no danger of the metal coming through the vulcanite. Those cases which were successful retained a good many stumps, so as to make a prominent and firm alveolar ridge giving a sort of grasp to the piece.

On the whole I have come to the conclusion that the judgment, as first expressed, was sound. Every full set which comes under care is met with a growing disinclination to omit springs. I am strongly of opinion that if the charm of novelty and difficulty which belongs to the idea of making a set without springs be discarded, small gain will be found to compensate for the many disadvantages and discouragements which will be met with in trying to avoid the use of springs. If springs were a new invention instead of an old plan, I strongly suspect that they would be hailed as

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perfection by many who now do not sufficiently appreciate them.

Spiral springs and their attaching swivels are too familiar to need description, and are best purchased from the Dental dêpots.

Washers should always be soldered on the pin of the swivel so as to keep the loop close to the head—a precaution not always adopted, much to the detriment of the piece, as either the loop works loosely on the pin, giving inconvenient freedom to the springs, or if the loop works against vulcanite it soon wears out from the fretting nature of this material.

To solder up washers on swivels is often the work of the young apprentice or pupil, and many failures he makes from the tendency of the solder to run further than required and fasten eye and pin together as well as pin to washer. The following method will be found to answer with care:—Mix a batter of whiting and water to the consistence of cream; take up a little of this on a fine point of wood, the end of a match whittled to a thin flat point, and with it smear the under side of the pin-head and so much of the pin as is equal to the thickness of the loop. Take hold of the spill of the loop with a pair of pin-pliers and slip the eye over the pin in the right way, place the head of the pin on the bench-pin, and hold the loop down tight upon it with the pliers in the left hand to prevent it slipping: smear over the under side of the loop with the whiting and water, but without letting any touch the pin. The whole of the pin-head within and under the loop, and the under side of the loop, will now be covered with a thin layer of whiting. Slip the washer or standard on the pin, press it down hard upon the loop, and catch hold of the pin close above the washer with a pair of pliers with the right hand, before letting go the pliers holding the loop in the left hand, in order to prevent any slipping, which deranges the whiting and sometimes makes a fracture in its continuity and allows solder to run through, or may work the whiting up between the pin and washer and so hinder the solder from soundly fastening these together.

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Still holding the pin firmly in the pliers place it in such a position on the soldering coke that no movement takes place when it is let go, by allowing the loop to rest at the bottom of a depression in the coke and the pin against the side, then touch the pin at the place where it enters the washer with a little borax. Apply the blowpipe to run the borax, and then place a small piece of No. 1 solder and run it.

If it is desired to attach the swivels to the upper gold plate a rather stouter and larger washer is required, which is then called a standard. The swivels on the standard should be soldered on to the gold plate after everything, but fixing the teeth on has been done to it, so that there is no more soldering to do afterwards. They should he fixed so as to work as nearly as possibly in the same plane with those of the lower piece, and as close to the teeth as possible. In order to do this the teeth should be mounted and tried in the bite with the lower piece, and the position and direction of the swivel scratched on the gold by a cross, one line of which is to denote the position of the pin-head, and the other that to be occupied by the base of the standard. Although not absolutely necessary or always practicable, the workman should aim at having his swivels set so that they work in planes parallel to each other, and to one dividing the whole set vertically and medially. To do this he will have to trust a good deal to his eye, and he must therefore pay the subject some attention. Having marked the position of the swivel he is now to solder it up in the following manner. A piece of binding wire is to be taken about nine inches long, and the middle wound tightly around the spill of the loop, this will leave two ends each four inches long with which to attach the swivel to the plate whilst soldering. The swivel is to be held as nearly in its place as possible, whilst one end of the wire is carried above the plate and wound around the nearest pins or other attachment. The standard may then be adjusted to a better position, in which it may be fixed sufficiently firmly for soldering by bringing the other end

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of the wire under the plate, and binding it in the most convenient manner available. A little borax is to be applied with a good supply of No. 3 solder. If the plate recedes much from the standard a short piece of fine wire may be dropped between them so as to strengthen the standard, for we must bear in mind that this part of the plate frequently requires to be filed back after trial, and it is excessively annoying to file out the swivel. The plate should be placed so that the blowpipe flame has access to it from below, and heat should approach on the opposite side to that on which the spill of the loop is bound so as to avoid the risk of melting it. In the lower pieces, however, and some uppers which have the teeth attached by vulcanite, the swivels will be fixed in the vulcanite. Such pieces are made by the ordinary method of pressing in a flask. The swivels can therefore be set up in the wax when the teeth are put up. In order that the position of the pins shall not be shifted under pressure it is well to put up the pins the whole of the length supplied, which is usually sufficient to allow the ends to come through the wax on the inside, so that they are held by the plaster when the piece is in the flask. Before putting the swivel in the wax the pin should be flattened in the middle by a blow on an anvil from the thin end of a hammer, to prevent the pin from turning or drawing after the set is finished.

It is of the utmost importance that the bow of the spring as it is bent when in use does not rest on any part of the gum; for this is perfectly unendurable. The greatest danger of this happening is usually in the lower jaw. It is usual therefore to leave a ledge of vulcanite here to support the spring as far back as the piece goes. A spring, which should be uniform in strength, makes a symmetrical curve between its two points of confinement, the pin-heads of the swivels. If these two points then are connected by a straight line, and this be bisected and a perpendicular erected at this point, this perpendicular will give the direction of the arch of the spring, the thrust of the spring being in the direction of the line connecting the two points of confinement.

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Now as the set does not always take up the exact position in the mouth, the upper relatively to the under piece, which was intended, it is well in making the set to put the upper swivel a little behind the lower to correct any little imperfection of this sort, and make sure that the upper swivel in the mouth is not in front of the lower, the effect of which would be that the arch of the swivel would point upwards, and might cause a sore by pressing on the mucous membrane.

The effect which the position of the swivels has upon the thrust of the spring is worth a little consideration, as in some mouths, where from the peculiar shape of the mucal base, the set has no very firm seat, it may be useful to set the swivels so as to correct a tendency of the set to slide in some particular direction. As previously stated the thrust of the spring will be in the direction of the line connecting its confining ends, which in most cases is practically the centre of the swivel loops. Supposing, then, that the right upper swivel is placed a good deal in front instead of a little behind the lower swivel, the tendency would be to thrust back the lower on that side and forward the upper, but as the ascending ramus of the jaw will stop the lower piece from going back, the practical effect will be to send the centre of the upper piece more to the left.

On several occasions I have been enabled to make an old set wearable by altering the position of the swivel where there has been a tendency in the pieces to turn round in the mouth. As a rule in such cases, however, a new fit or set is the best cure.

So much of the spring as is confined by resting on the plate, of course does not act in this thrust, the points of confinement only counting from the extremities of the bent part of the spring, nevertheless as in opening the mouth the resting part of the spring is set free and bends, it is usually safe to calculate the thrust in the direction of the line connecting the two swivel heads.

The following case will illustrate a difficulty in which the position of the swivels is of importance.

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Miss G— required a full set. The upper jaw presented no unusual feature, but in the lower the alveolar ridge was completely absorbed, presenting only a flat surface between loose tissues, the mucal base presenting much the shape of the flat surface of a horse shoe, if the free ends were bent upwards at even curves, these curves representing the back of the jaw as it ascended. The consequence was that when the set was put in the lower gradually slid forward until checked by the lower lip making the patient completely underhung. After many tedious alterations the defect was in a great measure remedied by making the upper teeth lap well over the lower so as to force them back in biting, and setting the swivels in the upper piece as far forward as the canines, so that the thrust of the springs against the lower was backwards. Unfortunately this patient died shortly afterwards of heart disease, so that I cannot speak of the ultimate success of this case, but the experience gained has since been successfully applied in three cases where a similar difficulty occurred.

Mr. W— presented a somewhat similar difficulty in the opposite direction. A complete upper required to be supported by springs, but in the lower jaw only the molars were absent, and the alveolar ridge made a regular and circular curve backwards from behind the bicuspids downwards, and then upwards. The front teeth rather inclined inwards, affording no support to the bar of the lower piece behind them. The swivels were placed, of course, as near to the bicuspids as possible; the consequence was that in wear the pressure of the springs at these points made the saddles on the ridges glide backwards on the curve, so that the ends of the piece behind were raised and the bar under the tongue was depressed, so that its upper edge, which should have fitted against the teeth, pressed upon and cut the gum at their necks inside. One of the bicuspids being badly decayed and the pulp dead the crown was cut off and a tooth added to the piece; this rested on the stump, and served as a stop, which completely cured the defect. This

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gentleman had two sets, in each of which the same difficulty occurred.

We are often asked whether it is requisite or necessary to have two sets, and in some cases, no doubt, this is advisable. If a patient is going abroad, travels much, so as not to have professional help readily available, or is so wealthy that the fee for an extra set need not be balanced against the slight inconvenience of waiting for a repair, there can be no objection to two sets, but as the majority of patients have, and in the nature of things must always have, plenty to do with their money, I think it will generally be best to discourage rather than recommend a second set. It is almost impossible to make two sets so exactly alike that they are equally comfortable in wear; that most in wear will be comfortable, and the other barely endurable for the short interval which it may require to be worn whilst the used set is being repaired. In the majority of cases the mouth alters so continually that a fresh set in the course of a few years will be a much greater boon to the patient than the possession of a duplicate of the first made. The old set can then be altered at small expense as a makeshift. This seems to me the most advantageous advice for the patient in such cases, and therefore also the best for the Dentist.

The lighter the springs which can be used the better. Nos. 7, 8, and 9 of Messrs. Ash's springs are those most generally used, but for patients with a powerful bite who complain that the pieces move in mastication, Nos. 10 or 11 may be taken. The length of the springs should be such that when the patient's mouth is opened to its full extent the springs are still a little bent, as if they become straight they may bend forward when the patient shuts his mouth after yawning perhaps, and produce an unpleasant embarrassment.

It would seem to be a very simple matter to put a pair of springs on to a set, but experience teaches that a pupil cannot often be trusted to do this until he has been two years in the workroom.

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The springs having been cut to the right length, and the burrs carefully smoothed off, tighten the coil at each end for a short distance by slightly hammering it with a light hammer on an anvil, turning it round at the same time so that the ends will hold the spills of the swivels moderately firmly; one end of the four ends, that to be put on last, of the pair of springs must be less tightened than the others. The springs are put on the upper or lower piece first by being screwed round as they are pressed on to the spills of the swivels. They must be screwed in the direction which rather tends to open the coil of the screw, as this enables them to go on easier, for the same reason in taking a swivel off it must be screwed in the same direction as in putting it on, only pulling at the same time instead of pushing, if it is attempted to unscrew it this action will bind it so firmly on to the enclosed wire that it will be found impossible to withdraw it. Both springs being attached to one of the pieces, the free end of one of the springs is now to be screwed on to the spill of the swivel of the other piece on the same side, allowing the already attached piece to hang down quite free, so as to move round readily with the spring as it is being screwed on the swivel. The spring cannot be screwed on the last swivel; it must therefore be forcibly pushed on, and a little care must be used in doing this not to slip and cripple the spring; but before making this last attachment hold up the set by one piece so that the other hangs downs quite loosely, the spring holding it being perpendicular. The faces of the teeth of both pieces should now lie as nearly as possible in the same plane, or the set will be twisted when the last swivel is attached. The swivels should be placed so as to balance the pressure over a nearly equal surface before and behind them, which will usually fall between the second bicuspid and first molar, but if they do not show, it is better to place the swivels in front of this point rather than behind it. It is advisable also to place the swivels so as to be as far apart as possible when the mouth is closed, as the springs work more pleasantly and last longer

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by not being too much bent, and are less likely to get crippled in wear. The ledge of vulcanite against which the spring checks in the lower piece should be quite at right angles to the motion of the spring as if it is only an inclined plane, the spring will get greater friction upon it, and the nature of vulcanite is such that it quickly wastes the spring, so that in vulcanite sets springs wear out twice as fast as used to be the case with gold or bone sets.

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CHAPTER XI.

ON MOUNTING TEETH.

At the present time there are three methods of mounting teeth on a metal plate commonly used in practice, namely, tube teeth, by pins, flat teeth, by plate backs, and teeth specially made for this purpose, and technically called vulcanite teeth, by vulcanite. Each has advantages over the others under certain conditions which it may be well to consider before describing the details of each method separately.

Judging from the directions given in their text-books and the teeth made by their manufacturers, the Americans do not use tube teeth at all. In England we have been in the habit of using all three methods, and are therefore qualified to judge of their respective merits.

The peculiar advantages claimed for tube teeth are, firstly, that they are readily removed so as to allow the plate to be repaired or added to by soldering at any future time; secondly, that some power of adaptation is available by letting a tooth down, allowing us to lower a tooth if too high to the bite.

There are two objections to the use of flat teeth entirely, which occur to me as probable disadvantages, but which, not being familiar with the use of these teeth for masticators, I only suggest for the consideration of those who are in the habit of using them. The first is that the attachment being on one side of the tooth the support to the strain of mastication will not be so evenly distributed as in a tube tooth, which is supported entirely below, being only kept in

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position by a central pin running in the direction of the greatest straining force in mastication. I should therefore be inclined to think, other things being equal, that tube teeth would stand mastication better than flat-backed teeth. The second hypothetic objection is that where all flat teeth are used, and soldered round the whole arch of a plate, I fear that the unequal contraction of the unbroken bar of solder which there will be may cause that warping of the plate in soldering which is so often spoken of in American handbooks as a dangerous difficulty.

If this is the case, as the danger occurs when there is no longer any remedy in our power but that of entirely remaking the piece, it would seem quite a sufficient disadvantage to throw the balance in favour of tube as against flat backs for the masticating teeth.

In choosing between tube or vulcanite teeth the principal determining consideration is whether any soldering, repairs, or alterations are likely to be required in the future.

The peculiar advantages of flat teeth are, firstly, they can be made stronger for a close bite; secondly, that they may be mounted on the plate with some plastic material (Ash's cement), which will allow of their exact adaptation to position in the mouth, which position can then be permanently and exactly fixed by soldering without undergoing any danger of alteration in the workroom afterwards. This is an advantage of immense practical importance, and one which also belongs in a lesser degree to the method of attaching teeth to a plate by vulcanite.

Another point in favour of attaching teeth by vulcanite instead of using tube teeth is that pieces so made are more cleanly, as food is apt to lodge in the interstices between tube teeth, whence it is not always easy for the patient to dislodge it, and where it soon becomes offensive.

The cost in labour of attaching teeth by vulcanite is much less than that of mounting tube teeth, but this may be considered an advantage, or the reverse, from different standpoints.

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On reviewing the fitness of these methods for different conditions, I think we may draw the following conclusions.

For sets where the gum does not show and a few of the masticating teeth remain, which may necessitate an addition to the plate at some future time and perhaps the addition of springs, if these alterations will require soldering to be done, use tube teeth altogether. Such cases, however, are not common, but one passed through my hands a short time ago which was best met in this way.

For partial gold pieces where the front teeth have to be accurately fitted to cover stumps, or nicely adjusted between natural teeth, use flatbacks for the front teeth, and tube teeth for the masticators; in which case mount the tube teeth first, *i. e.* mount all the teeth approximately to the bite, fixing them with cement, flat backs as well as tube teeth; this will give the position for the pins of the tube teeth with sufficient accuracy, and they should be soldered to the plate before the flat backs. This will allow of the flat backs being adjusted to the mouth with cement before being finally fixed, and will obviate any soldering being subsequently required.

Whilst for nearly all complete upper dentures and many partial ones where, if the natural teeth are lost, the case will admit of the vacancy being filled up by the same method, vulcanite will, I think, be the best way to mount the teeth.

When I entered the workroom nearly the whole work was gold and tube teeth, and the labour of putting up these formed a large part of the occupation of the pupils and workmen. The rate at which teeth could be mounted was a subject of emulation, and it was found that to mount three teeth an hour, from the time the plate was finished to the time the tooth was "fine fitted," was good work. This included rough fitting, mounting the pins, fine fitting, and finishing off the pin heads on the under side of the plate. I have known the fourteen upper teeth mounted in three and a half hours, or at the rate of four teeth an hour, but only on one occasion.

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To mount tube teeth rapidly, the workman should have all his tools at hand and in good working order, as if he has to spend his time in looking for these, although he does not tire himself by working, yet the work does not get on; whereas if he does not use tools which exactly do what they are required, but uses makeshifts, he will tire himself a great deal more by the work, which will then not be so well done.

Three special tools should be kept in his drawer for this work alone.

A counter-sink.—This tool is for clearing away the burr of the tube on the ground end of the tooth, and for slightly enlarging the entrance to the tube here, so that there shall be no danger of the foot of solder which slightly rises around the pin at its base from splitting the tooth. A counter-sink should be a cylindrical piece of steel so large that there is no danger of its being forced, when used, into the tube and so splitting it, but no larger, or it is inconvenient. A small rat-tailed file makes a good counter-sink, the tang stuck in a wine cork for a handle, and the other end ground to a pyramidal point with three sides.

A marker.—This must be a piece of straight cylindrical steel wire which exactly fits the tube of the teeth used. One end of this is also to be sharpened into a three-sided point. Its use is to mark exactly the place of the centre of the pin-hole when the tooth is mounted. It must therefore fit the tube well without being tight; if too loose it will not mark truly.

The third tool is a drill which will make a hole the exact size of the pin used, so that the pin, when put in the hole, will almost stay in position without support.

To make this, take a tapering drill brooch which will pass through the pin-hole in the wire plate almost, but not quite, up to its shoulder, then break off the point, leaving an inch from the shoulder, and sharpen this to a spear point in the following manner:

Grind the end from both sides to a wedge shape, allowing a quarter of an inch for the taper, then sharpen the end on

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the hone like a chisel, also on both sides, but keeping a square end. Still keeping a sharp edge, proceed to take off each angle by rubbing the corners on the hone obliquely until the point meets in the middle, each corner being chamfered from the opposite side.

These tools being provided, tube teeth should be mounted in the following manner:

We will suppose we have in hand a complete upper denture with the six front teeth to be let down on the gum. The two centrals should be let down on the model to the bite without the plate. They are then to be put on the plate, stuck there with a little cement, and the two holes marked for the pins; this will enable us to judge how much of the plate it will be necessary to cut away to allow the front of the teeth to cover it and reach the gum. When this has been done, the centrals are to be let down over the plate to the gum and again fixed. The laterals and canines must be let down in rotation sufficiently to mark their pin-holes before the gold of the margin beneath them is also filed back to its final position, when they are also let down into position. The masticating teeth are then proceeded with in due order, only without marking until all are mounted. Each tooth should be left a trifle too high to the bite to allow for fine fitting after the pins are up.

To let down a tooth.—Try its length approximately by holding it in position on the bite, but upside down. If much too long, cut off as much of the neck as is prudent with a small steel adze, which is generally made by grinding one end of a rivetting hammer sharp. This is done by holding the tooth on a piece of lead, marking the place of section with the thumb-nail and covering the crown of the tooth with the thumb, so as to guard it at the same time. A slight tap with the adze, allowing it to be guided to the indicated spot, will generally give the required fracture with sufficient exactness.

To grind a tooth rapidly, hold the edge of the tooth so that an equal amount of the two surfaces making the edge are

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encroached on by the wheel. Continue to take off the edge all round in this way until the end of the bottom of the tooth is reduced to a cone, then truncate the cone until you get a square end to the tooth again and proceed as before. Long upper laterals or lower incisors will require shortening in this way, as if it is attempted to crack them with the adze they are very apt to smash. Having reduced the tooth to the desired length, proceed to fit it to the plate. For rough fitting before the pins are up it is not necessary or desirable to use paint. Place the tooth against the plate and mark with the eye where the tooth touches, grind this away and repeat the process. If the part which touches is out of sight grind the whole under surface of the tooth hollow; so long as the margin touches all round, the accuracy of fit is quite sufficient. The tooth being sufficiently let down by the bite, counter-sink the hole on the ground end and clear the tube well with a tube file. Now fix it firmly in its place by dropping melted cement so as to fasten it to the plate and its neighbours; Ash's cement I have found most convenient for this purpose.

The teeth being all firmly cemented in place, mark the place for the pins by passing the marker down each tooth, and rotating it whilst pressed against the plate below. Remove the teeth by warming the plate, and arrange them before you on the bench in the same order in which they stood on the plate, about an inch from the margin of the bench, so that you can take up any tooth you want directly without having to hunt about for it.

With a pair of punching pliers now punch out all the holes for the pins, taking care that the centre of the pin of the pliers is on each mark before punching the hole in those parts of plate where the plate is at right angles or makes equal angles with the pin all round. Where, however, the plate makes an acute angle with the pin on one side and an obtuse angle on the other, the hole must be punched a little way from the mark on the line of the acutest angle, or as a workman would say "up the hill on the steepest part of the

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hole, when the pin is on an inclined part of the plate, about half the thickness of his plate from the mark down the line of the steepest part of the incline, but more or less in proportion as the inclination is more or less than half a right angle, only giving more allowance in proportion as the inclination is greater than this.

Having punched all his holes he must now bore them out to the right size and direction with the drill. To do this at first pass the drill through the holes at right angles to the surface of the plate, and then rotate the drill whilst it is being brought into the direction which it is desired that the pin shall take; whilst in this position and continuing to rotate it pass the drill through up to the shoulder. The pinhole is then made, and should now have the burr removed by file and sculper. All the pinholes being finished the plate is to be placed before the workman on the bench whilst he cuts the pins. Let him take a length of pin wire in his hand and file the end at such an angle that when put through the pinhole of the last molar on one end of the plate it makes a flush surface with the under side of the plate. This precaution will save a deal of time otherwise spent in sculpering down the projecting ends of the pins after soldering. A slight notch should also be cut with the file on the end of the pin longitudinally to allow the solder to run from the upper to the under surface of the plate more readily. The end of the wire having been thus prepared for the terminal pinhole, take up the corresponding tooth, pass the wire through from the coronal end of the tube until it slightly projects from the ground end, and then with cutting pliers cut it off flush at the coronal end. This will give a wire the right length. The tooth is to be replaced on the bench with this pin besides it. The next pin is prepared in the same manner, and all the others in due order, taking care that pins and teeth are maintained in their correct positions. The next process is to place the pins in the plate for soldering. Heat and pickle the plate in acid to clean it, and then wash in water, and whilst still wet rub a little

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powdered borax with the finger into all the pinholes. Take a piece of binding wire of sufficient length, make one end into a small hook so that it will catch on the edge of the plate, now take the pin belonging to the end hole, wet it in clean water and insert it therein, catch the hook of the binding wire on the most convenient part of the edge of the plate, draw it tight and give it one turn around the pin, place the second pin in its hole, bring the binding wire on and secure it also by one turn, do so with all the rest of the pins, and then fasten off the binding wire by giving it a sharp turn over the edge of the plate on the opposite end to where it was first attached. On looking at the under side of the plate it will be evident that the pins want a little adjustment before soldering to make their ends even with the surface of the plate; this is easily done.

The plate is now to be heated with the blowpipe before applying solder to it in order to fuse the borax which will otherwise displace the small pieces of solder, as it rises on being first heated. It is of some consequence to the workman to get his solder cut up to the right size uniformly. Too much solder will give him future trouble in letting down the tooth over it, while too little will leave his pins weak. A very small piece, however, is sufficient; the beginner generally errs on the side of using too much. Number three solder is always to be used in soldering up pins, as this is generally the last soldering done, and the lower the temperature to which the pins are subjected the less will the fibrous texture of the wire be destroyed. Place the plate in a firm position on the soldering coke, and place a small piece of solder at the foot of each pin so that it rests partly on the plate and partly on the pin, and run the solder with the blowpipe. It will not be generally practicable to put solder to more than a third of the pins at once. When all are soldered on the upper surface, turn the plate over and with the blowpipe draw the solder through to the under side of each pin separately. The teeth are now placed on the pins, and these are to be bent a little, one way or another,

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until the teeth stand in their correct positions. The bottom of the pins being in the right positions, it will only be their inclination which will require rectification. This can be done by a pair of pliers holding the pin close to the plate, a sculper, or by using the instrument designed for bending the pins of pivot teeth previously described. The teeth are next "fine fitted." To do this take the teeth off the pins and place them again on the bench in their right order. Put the plate on the model and try it in the bite, should any of the pins be too long reduce them to their proper length.

In fine fitting the teeth, begin with the centrals finishing on each side alternately. Paint may be used for fine fitting. This is made of vermillion or rouge, mixed up with a little olive oil; it should be thick, and a very little used at a time to give correct indications. For fine fitting small wheels are necessary, but it is a great mistake to use them for the rough grinding previous to the mounting of the pins. Then large coarse thin wheels of three inches in diameter are best, and they should be discarded when reduced in diameter to rather less than two inches.

When the tooth is finished letting down, the roughness of the ground edges should be smoothed by just touching this edge against the side of a fine corundum wheel in motion, drawing this edge lightly longitudinally in the opposite direction to the motion of the wheel. The end of the pin, as it comes through the tooth, may be finished off by filing it so as to show a hemispherical end, or by grinding it off flush with the surface of the tooth whilst this is in place. The roughness of the ends of the pins on the under surface of the plate is now to be reduced by the sculper and fine corundum file to a smooth surface. The plate is now ready to be polished after which the pins are to be roughened with the pliers made for the purpose, or by making a few small file cuts on each pin. A couple of turns of fine floss silk is then taken round each pin, and all the teeth having been made perfectly clean, are placed on their respective pins. The

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teeth are then fastened on with sulphur, in the manner too familiar to need description, and the piece receiving a final cleaning and polish is ready for the mouth.

The sulphur used for cementing the teeth in position will be made much stronger if it has been first melted for half an hour in a Florence flask and is then poured into cold water, this will change it to a light chocolate colour and make it much tougher in consistence.

In mounting flat teeth it is not proposed to use them for mastication, but for those cases where the great facilities which they offer us for adapting them on the plate in the mouth make them specially advantageous for front teeth. The great majority, therefore, will consist of the front six or eight teeth, and as we shall have to move them on the plate before finally fixing them there, it will be evident that we must not try to give them any strength by allowing them to rest on the plate. The whole of the resistance to the force of mastication must therefore be taken by the back, or if any falls on the tooth, by the hold which the tooth has on the back. The back should therefore be stout — No. 8 or No. 9 plate—unless the bite is very close. Gold has a tendency to bend or rivet under repeated blows, and thus accumulate the force of successive slight shocks. For this reason, if there is an edge-to-edge bite or the teeth are long, it is not well to bring the gold up to the edge of the tooth, as in the first place the edge is apt to get rivetted down by the force of mastication which makes a burr, and finally forces off the tooth from its back, and in the second place the back gets slightly bent, equally ensuring the destruction of the depending tooth. On the other hand, the back must not be too short. The platina pins by which the tooth is attached to the back are readily bent, and act more like a ligature binding the tooth on to the back than like rigid bars. If the edge of the back, therefore, is close and parallel to the line of the two pins, above or below, a very small force applied to the other extremity of the tooth will cause the tooth to separate from the back there, turning

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over the end which was close to the pins as over a hinge, bending the platina pins and breaking the tooth. Leverage has a great deal to do with this manner of breakage. Considering the tooth as a lever, the pins as the weight to be moved, either end of the back will be the fulcrum, and the opposite extremity of the tooth the place where the power is applied. Then the further the fulcrum, that is, the end of the back, is from the pins the less power will there be at the other end of the tooth to lift the weight, that is, bend the pins.

For these reasons it is best to have a tolerably long back as well as a stout one, and yet not reaching up to the edge of the tooth; the edge of the back should be left stout, not bevelled down too finely, as although this gives a nice looking finish these thin edges are apt to get rivetted down.

Where teeth are set to the gum if space has to be economised in the back it is well to let the pins be nearer the upper than the lower edge of the tooth, as all the force which falls against the tooth is that of direct mastication, but if there is a stump beneath it is best to get the pins in the middle of the back and grind away the tooth above or below according to circumstances; as if you have a very short back in such a case, and the pins are close to the top or bottom of the back, a return of the piece shortly with a fractured tooth may be confidently expected.

To put up flat-backs.—Let the teeth down on the model to the bite without the plate. If there are any natural teeth take care that the artificial teeth stand rather higher than these to allow for the softness of the mucal base. Place the plate on the model and file it back so as to allow a little tongue of gold to stand under each tooth, not as a support to the tooth, but as a more comfortable saddle to the gum. Now back the teeth. To do this punch a couple of holes for the pins of the tooth in the most economical position of your piece of gold. Put the tooth on the plate, the pins being in the holes, mark round the tooth with a sharp point, remove the tooth and cut out your back. File up and sandpaper

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the two sides and the cutting edge as you wish the back to be when finished. Try on the tooth and see that it fits closely, if not, remove any burr and bend it until it does fit. Place the back on the tooth for the last time and fix there by bending the pins over it, upwards if the pinholes stand low so as to be close to the plate, downwards if the reverse is the case. The pins should never be rivetted, as this prevents the solder running through, and if the head of the pin requires to be ground off for the bite, away goes the tooth. Bending the pins on the back allows the solder to flow well round them and strengthens the back at the same time. The ends of the pins should be filed flush so that all is smooth to the tongue. The teeth being backed let them down over the plate to the model, again grinding away the back and under side of the tooth freely, but without touching the front again until it goes easily into its place without touching the plate.

Heat the plate and rub a little Ash's cement on it, do the same to the backs of the teeth. Put the teeth in place on the plate on the model and fix them by dropping a little of the cement behind each.

Now try in the mouth; if it is cold weather just dip in warm water for a moment before putting in the mouth. When they are adjusted remove from the mouth and drop a little more cement behind each, and when this is cold try them in again to make sure that they are all right.

The teeth must not be allowed to touch or rest against anything from this time until safely invested in a batter composed of two thirds plaster and one third sand, mixed with water. A heap of this batter should be poured on a piece of paper on the bench, and the piece placed on it and gradually settled into it. The investment should occupy all the under surface of the plate and teeth, and be brought over the faces of the teeth and a quarter of an inch above their cutting edges. When set it should be trimmed so as to be about a quarter to a third of an inch in thickness everywhere. Remove the cement with a stream of boiling water.

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If there are any gaps now visible between the backs of the teeth and the plate, drop small pieces of scrap plate or short bits of wire to fill these up, and cover all the pins and joints with a liberal supply of powdered borax and water.

To heat up before soldering place the piece in a wire cradle over the flame of a Bunsen's gas burner, as long as the heat only reaches the teeth through the plaster there is no fear of cracking these, as plaster is a very slow conductor of heat. Should there be a fire in the workroom the workman cannot do better than rake a place in the cinders free from flame and smoke and place the piece at once on the red embers, taking care that the plaster is between the teeth and the greatest heat. When the heat has passed through the plaster and teeth and raised the borax there will not be much danger in proceeding to solder; but it is well to give a few minutes grace after this. Whilst the piece is heating get your soldering coke, corn tongs, blowpipe, solder, &c., ready, as no time should be lost when the piece comes out of the heat before commencing with the blowpipe flame. No. 3 solder should be used, and a generous supply of large pieces supplied, as the bases of the backs of the teeth require good support.

The use of the blowpipe has been often described, but as some pupils still find a difficulty in mastering it, a few words on the subject may not be amiss.

The first thing to be learnt is to keep up a steady blast instead of intermitting with the breath. To learn this, distend the cheeks, keeping the mouth shut and the tongue drawn back. If the pupil can now breathe regularly through his nose he should have no further difficulty; this is the first step. Whilst the cheeks are distended insert the blowpipe between the lips; the elasticity of the cheeks and the compression of the cheek muscles will now force the air out of the cavity of the mouth through the blowpipe without at all interfering with the regularity of the breathing, and when the cheeks are collapsed a further supply is obtained by protruding the tongue like a piston towards the blowpipe.

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Before this supply is exhausted the cheeks are distended with a fresh supply of air from the lungs, and the process is continuously repeated. Thus a constant stream of air can be kept through the blowpipe without distressing the lungs in the least, and the workman is only limited in time by the powers of endurance of the muscles of his lips to continue their grasp on the blowpipe.

In using heat by the blowpipe it is always easier to regulate the application with greater precision, as with other forces, when there is a large surplus of power at disposal, than when the workman is straining his endeavours. Heat flows into and out of a gold plate almost like water through a sieve; if, therefore, the workman tries to solder any point by directing the flame first and only upon this the great loss of heat by the conduction and radiation of the rest of the plate will call for such a great supply of heat at the desired point that his powers will be heavily taxed, perhaps beyond his control, and he will melt or sweat some part to his mortification. To avoid this let the support of the plate be a non-conductor of heat so shaped as to shelter the plate as much as convenient from the radiation which free exposure allows. A piece of close coke answers exceedingly well. Cut out a bay or dock in it large enough to hold conveniently a large plate, bind the part to be held in the hand round with iron wire, and coat it with plaster trimmed to a convenient shape in order to make it durable. The plate to be soldered is placed in the dock in the coke in such a position that the flame of the blowpipe can be played all around and under it. The whole of the plate is first heated to within a a little of the melting point of the solder, say a dull red, by a large brush flame, and when it has arrived at this state a fine-pointed flame is suddenly directed upon the solder or upon the largest piece of the gold contiguous to it, the solder will immediately melt and flow in the direction of the greatest heat. It must be borne in mind that small bodies heat much more rapidly than large ones, so that if a pin, for instance, is being mounted much more heat must be given to

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the plate at the point of soldering than the pin, or the latter will melt before the plate is hot enough to allow the solder to run. As long as the two parts in juxtaposition are kept at the same heat, which can be judged by the colour, and that the greatest point of heat is on the plate, there will be no fear of sweating or melting any part as long as the solder is unmelted. A large brush flame is made by holding the point of the blowpipe a short distance out of the flame, and this is altered to a fine-pointed flame by suddenly thrusting the point of the blowpipe into the flame.

Vulcanite teeth are attached to a gold plate by using vulcanite as a medium; it supports the teeth by fitting them accurately, maintaining a hold of them by their pins, or by their shape being particularly constructed to give a hold to the rubber by allowing it to permeate cavities or surround dovetails in the substance of the tooth. Of these methods I must express a preference for the pin teeth. The vulcanite in its turn is attached to the plate by pins or scraps of plate soldered to the plate which the vulcanite envelopes. After trying various methods such as cups, scraps, &c., I find fine pins are the least inconvenient in working. Ten are a good number for a complete upper, one behind each central so as to stand just between the pins at the back, one on each side behind the division between lateral and canine, one between the bicuspids, and one opposite each molar. To put them up mount the teeth approximately on the plate in wax and mark the spots through the wax on the plate with a drill, punch holes and put up the pins as for tube teeth, letting the pins be an eighth of an inch in length, and sweat the top of each pin into a head with the blowpipe after soldering.

Remove the teeth and put up modelling wax in blocks on the plate for the molars, and bring a rim of wax round the front of the plate to carry the front teeth. Put up the two centrals and try in the mouth, get the right bite on the wax blocks first in the mouth, and then adjust the two centrals to their desired position, proceed to add the two laterals, and then the canines and bicuspids if necessary. If either of

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the pins prevents a tooth being moved in the wax cut the pin off, as it will give you less trouble to do so than to try and bend or file it in the wax.

If you are making an entire set it is best to get the upper teeth arranged first to your liking, because the position of these is of more importance in the expression than the lowers are, and will give you more guidance by their appearance. Make a lower trial piece of modelling wax and make a bite; as this is only to be used temporarily it will not be necessary to make it in plaster, Godiva or Stent's modelling composition will do it much quicker and is cleaner. With this bite arrange the lower teeth on the trial piece to suit the upper, and try in the mouth again for correction. Having made the final adjustments fasten the upper and lower pieces together in the mouth by thrusting a hot spatula between the wax of the upper and lower blocks on their line of meeting so as to melt them together, directing the patient at the same time not to open his mouth for a minute or two until the wax is cold. Remove the whole set in one piece and make a fresh bite in plaster of paris.

The rest of the teeth are now to be put up in the ordinary way with modelling wax. When finished with wax remove the plate from the upper model, fill the under surface with plaster and set in the lower part of a flask; when hard rub a parting over the exposed surface of the plaster, put on the upper part of the flask, fill up with plaster, and when set separate. Remove the gold plate and stream out the wax with boiling water. If you have cut away any of the pins in putting up the teeth now is the time to replace them, put a little column of wax on the plate where you judge the pin should stand, and drop the plate into its place in the flask again; this will receive marks from the adjacent pins of the teeth, &c., and serve as a guide for the putting up the pins on the plate again. When these are soldered up see that the plate drops quite down into its place as if these fresh pins bear upon the teeth they will probably break them in screwing up. Proceed to pack the piece in the ordinary

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manner, but do not put the gold plate on the lower part of the flask until the piece has been perfectly packed and pressed, after being boiled, until the two halves of the flask come quite close; now with a hot instrument remove all the overflow of rubber, and a little more than this all round the margin to allow for the space occupied by the plate, put this on its place in the lower part of the flask and close, boil and press for the last time, when the flask is ready for vulcanising.

When vulcanised finish in the ordinary manner. As the ridge of vulcanite which supports the teeth on a complete upper denture made in this manner considerably stiffens and strengthens the piece, it is not necessary to use such thick gold as for tube teeth; instead of using plates of No. 8 or No. 9 gauge thickness, No. 7 or 8 will be sufficient.

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CHAPTER XII.

ON THE ARRANGEMENT OF ARTIFICIAL TEETH WITH REGARD TO PERSONAL BEAUTY.

When the pupil is promoted from the workroom to the operating-room, or on commencing practice begins to have patients of his own, he finds himself confronted by a class of difficulties which previously he had taken little account of, and which are not less real than the troubles of the workroom, although not so definite or tangible.

He wishes to please himself with the appearance presented in the mouth by the teeth he adapts for his patients—he wishes to please them, he wishes to please their friends, and he wishes to do himself credit with the general public, but he finds in practice that the opinions of the four interests indicated under these heads do not always coincide so exactly as he may think they ought to do in theory. He has been working with or for an old-established practitioner, and he is surprised to find that the choice and arrangement of teeth which under this superintendence was a matter of course, and of the greatest ease, has now become a matter of great uncertainty and anxiety. Persons whom he is convinced would have been satisfied with anything his old preceptor liked to place in their mouths do not scruple to criticise the effect which those he puts in produce even after he has taken great pains. To pacify them he explains that he has used the best and most expensive teeth of the best makers, but they still persist that they are not satisfied.

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He assures them that he has had great experience, that it cannot be done better, and perhaps, thinking it time to take a firm stand as a professional man and control their whims and fancies, says that they must trust to his judgment, that the teeth feel strange at first, but that a little time will reconcile them to their appearance; they, however, sometimes have the bad taste to retort that nothing would induce them to wear such things for a moment even if obliged to pay for them. He is now reduced to the extremity of maintaining his dignity and losing his patient, and probably a connection; or if he has too much sense to do this he will eat humble pie, alter his work, and try if he cannot hit the mark better.

We will suppose in another case that he has pleased himself and the patient. The fee is paid, and matters are so far comfortable, when he learns that some friend or relation of the latter whom he had expected on his recommendation has gone somewhere else for a set on seeing his friend, and this gives him an uncomfortable misgiving that all was not as it seemed. Or, one day some unprejudiced and indifferent patient casually remarks to him, "What a frightful set of teeth Mrs. Blank has! Who ever made them? I wouldn't go to that Dentist for anything;" when he finds it expedient to pass the subject as lightly as possible.

All this is very trying to the young Dentist, and he feels inclined to say that it is merely a matter of taste—"Tastes differ." He does not see why his is not as good as any other person's. It is only because he has not made a name, and so people have not faith in him which makes them hypercritical. If a well-known man had put in the sets it would have been all right. This is partly true, no doubt. Tastes do differ. Of two competent practitioners in the same town one will use a great many more of one maker's teeth, or one particular style of teeth, and mount them generally in such a way as to be distinguished from the other, yet both will be equally successful. Each is following out some rule or taste of his own, however, which experience

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has endorsed, and does not merely follow his individual fancy. A good taste, therefore, is to be cultivated, as, when acquired, it is the best directing guide which can be had. The young Dentist is sure to have a taste of his own, in the correction and management of which his great difficulty lies. It is generally good enough to approve of the appearance of a set when it is right, but not good enough to show him how to get this appearance when it is wrong; and it often becomes so prejudiced during the process of making and finishing the work as to have lost all true judgment by the time this is placed in the mouth.

Without doubt patients are more critical and suspicious of the beginner than of their old tried friend. But then they have a perfect right to be so; he is comparatively inexperienced, and has no right to expect the confidence which he has not created. He must remember that they come to him between hope and fear, wishing to do him a good turn if they can, perhaps hoping to get their work done at a less price; but when they find themselves in his hands an instinctive dread, born of the facts of the case, seizes them that they may have made a mistake, and this sharpens their suspicions and magnifies defects. If he will now take pains to do something for his patient as well as for himself by really satisfying the requirements of the particular case, he will secure a friend who will sound his praises on every suitable occasion.

As has been said before, the natural taste of the pupil has to be corrected and educated, to do which in a general way he cannot do better than read Lavater on 'Physiognomy,' and Ruskin's 'Modern Painters.' He will not find much definite or practical help from these, but they will show him how wide the subject is, and disabuse him of some pet notions of his own which might lead him into bad mannerisms. He may have a bias towards pretty little teeth or large bold teeth; or think that the patient will be pleased with nice white or bright teeth; that self-coloured teeth have an educated air, or dark teeth look natural; that it is well to

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point the arch a little, give it a good bold sweep, make it perfectly symmetrical, or set the teeth a little irregularly; to point the front teeth forward, or make them stand well upright; to keep the cutting edges as received from the maker, or to notch them. These expedients are all good in their places, but neither must be used unsuitably. It is clear, then, that we must keep these four points always in view:—Please the patient, gratify his friends, do ourselves credit with the public, and gradually improve our own taste and judgment, avoiding any peculiar style or mannerism. We are not altogether to copy nature, for no one can be more alive than the Dentist to the fact that the natural teeth are often anything but a standard of beauty as a feature. On the other hand, we cannot construct an ideal type by making an abstract of the characters of the most beautiful natural mouths we meet with to be applied in every case. If we do this we shall find that, although the set may look beautiful in the hand, in many mouths it will at once impress the beholder as being a foreign body.

Every organ more or less expresses the character of the individual to whom it belongs, and the teeth do so in no small degree; therefore, if they do not harmonise with the rest of the characteristics of the patient, a false impression is at once produced.

Most people wish that their appearance should be of as much advantage to them in their social intercourse as possible, and however strongly they may assert that they only wish for comfort and use, we shall do well to accept the statement with certain allowance; still, it is to be remembered that many persons have a more or less vitiated standard of excellence in their own minds, which is often produced by a tendency to go to the opposite extreme of some defect from which they have suffered themselves, or disliked in the appearance of others; the general desire seems to be to have small bright white teeth, regularly arranged; as a rule, the less refined and educated the patient the more strongly will this type be insisted upon; and although this taste must not

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be yielded to, so far as to give the patient a very artificial or formal-looking set, we must not altogether lose sight of it.

It is, on the other hand, to please patients of the highly refined and cultivated classes that we find a real difficulty; these appreciate a harmonious choice and arrangement, and their approval is often a guarantee and forerunner of that of the more general public.

To arrive at this desired result, it is a good habit to take special notice of all the good-looking natural mouths possible, the shaped tooth, whether long or short, narrow or wide, to compare with the general contour of the face; the colour of the teeth should be compared with the complexion and age, the boldness or otherwise of the arch, and the relative position of the upper and lower teeth, with the general expression of character as whether muscular, bold, firm, active, impulsive, amiable, intelligent, or the reverse. Then, as to their exact symmetry, and how far this is consistent with age, though upon this point we shall generally be obliged to flatter our patients a little. After a time a certain judgment will be formed, so that on looking at a person the Dentist will see in his mind the sort of teeth which will suit him, not the highest ideal perhaps, but at any rate what will look harmonious, natural, and pleasing.

We shall be guided by any natural teeth the patient may have remaining in matching the colour, usually allowing the upper artificial incisors to be half a shade lighter than the natural canines or lower incisors. If there are no natural teeth, the complexion of the face must be our guide; a brilliant, transparent florid complexion may have the brightest and whitest teeth, with the slightest yellowish tint towards their roots; a strong, healthy, sanguine complexion should have yellowish teeth; a fair, pale complexion should have pale, self-coloured teeth; a dark, pale complexion may have dusky yellowish teeth; whilst a sallow complexion should have medium self-coloured teeth.

The choice of the shape of the teeth should also be

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matched by the natural teeth, if these are in existence; if the front incisors have been extracted by the Dentist previously to his adapting the set, it is a good plan to keep them in water, in little wide-mouthed bottles, in the work-room for reference when choosing the substitutes. In default of these aids, however, we must have recourse to the general appearance and contour of the face; a large face should have large teeth; a small face, small teeth; a long face, long teeth; a broad face, broad teeth.

But there are delicate varieties of expression to be indicated by the teeth besides those of colour and outline. Some persons of a highly delicate and refined class have long light teeth in which the transverse contour lines are very characteristic. Messrs. Lemale have imitated these in some of their patterns, with an artistic feeling which leaves scarcely anything to be desired; the same remark also applies to their lower incisors generally. Other persons belonging to the educated but yet active classes have teeth in which the transverse contour marks are not to be seen; these teeth are quite smooth or have only longitudinal depressions on their faces. Messrs. Ash have types of this class of teeth, which for form, finish, and texture are admirable; American teeth, although not equalling the previously named makers in texture and form, have a naturalness in translucency, and in the gradation of this from the tip to the body, which cannot always be obtained in English teeth; whilst American gum blocks are excellent where they can be judiciously used. The Dental Manufacturing Company have among others produced a vulcanite tooth with a long enamel, and thin cutting edge, which has an individuality and brilliancy of appearance which have an excellent effect in mouths where long bright or white natural teeth have to be matched, and a little space left between them.

The position of the teeth in the mouth is the next consideration. The two faults to be especially avoided are the production of pouting or flatness. Let us suppose the four upper incisors need to be replaced between the natural

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canines: if we have the option, we shall retain the stumps in order to keep out the fulness of the gums; but if these are absent, the alveolar wall will have been absorbed, the gum will have fallen back, and we shall be in danger of putting in the teeth too short, giving a flatness to the teeth which causes a sour expression in the face. The cutting edges of the incisors should be on a horizontal plane, even with, or a little lower than, the points of the canines; the cutting edge of the laterals may be a little higher than this, so as to make a slight step between the distal angle of the central and the mesial edge of the canine. This rule is subject to some variation; if the teeth are perfectly upright, or pointing slightly towards the cavity of the mouth, the edges of the incisors should be in the same horizontal plane with the point of the canine, or slightly lower; whereas if the teeth are rather projecting, a more decided step between each of the three teeth will look well.

As the cutting edge of the tooth is where that of its natural predecessor was, and, as the gum has receded, it is obvious that it will require a longer artificial tooth to reach the gum; if the patient in smiling shows these, and they have an unpleasing appearance, especially if it is a young lady, adapt gum blocks to the case. When persons smile or laugh in animated conversation, they usually separate the lips to a distance sufficient to show the whole of the upper and lower teeth, but the upper lip rises more than the lower lip falls, and the corners of the mouth are drawn backwards and upwards. In consequence of this some of the upper gum is usually shown and only part of the lower teeth. (See fig. 55.)

This rule is by no means unvarying, as the division between the teeth does not always correspond with that between the lips when closed, but is sometimes above and sometimes below it.

In young persons, or those of little muscular tone, the teeth will not be much worn; it will therefore be natural to such patients to have teeth with their cutting edges slightly

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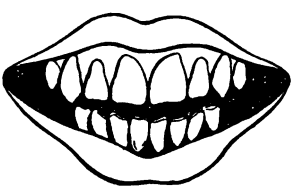
round, and the distal and mesial angles not very acute; whereas with persons of powerful, muscular, masticating force it will be well to grind the cutting edge of the cutting teeth to imitate the wearing of the natural ones. In doing this the cutting edges must not be made to present a continuous line, but each tooth ground so as to preserve its individuality, as this is one of the great points to be aimed at in artificial teeth, so that the cutting edge of the set presents a broken, uneven, angular line, which is still fairly symmetrical. The lower teeth should be ground to correspond so that when they are brought together their edges will fit those of the upper as if they had functionally worn each other; this gives a very natural appearance. Some persons

FIG. 55.



have very brittle enamel, or from other causes the edges of their teeth get notched by small fragments chipping off; it is well to imitate these by grinding notches in the cutting edges of the artificial teeth where these have to match the natural ones, or even where they are opposed to them. Honey-combed teeth may be successfully imitated by grinding and filing into the face of the mineral teeth, using the natural tooth as a pattern.

The degree of arch which should be given to a full set may sometimes be judged by the curve of the upper alveolar ridge, but in some patients this is absorbed to a much greater extent than in others.

As the canine is the combative tooth it is evident that prominence of this, giving a squarish arch, is a masculine expression, and should be reserved for a man. The lower

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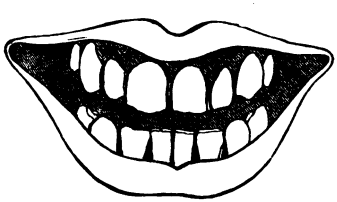
teeth should never be set further out than the upper, but they may be placed edge to edge with them, which gives a firm or determined aspect, more suitable for a gentleman than a lady; whilst to put the lower teeth a good deal behind the upper, which would give a hesitating timid air of a man, is sometimes quite becoming to a lady, having a pleasing gentle look. Prominent teeth, rather slanting forward, give an open talkative air, whilst the reverse effect is produced by teeth out of sight in the cavity of the mouth.

In mounting a full set we first proceed to get the two upper centrals in place. The teeth having been chosen, and the plate struck up, if a gold plate is to be used, or a trial plate of wax moulded to the model if for a vulcanite set, mount the two centrals approximately in wax, and adjust in the mouth. Take care that the mesial division of the teeth is in the central line of the face, carried down from the centre of the nose and lips, and that the teeth are far enough forward to keep the lip in a natural position without pouting it. When the mouth is quietly opened, without drawing up the upper lip, usually the teeth should show for

FIG. 56.



the sixteenth of an inch. Be careful that the cutting edges form a horizontal line, or are evenly inclined from it on each side of the median line. When the two centrals are mounted proceed with the other teeth, one on each side at a time, and see that the patient in smiling uncovers the same amount of the teeth on each side at once (see fig. 56*).

* By an error the engraving represents the upper incisors unsymmetrical in shape and position. This is unintentional.

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Where the line of the mouth is not horizontal it is best to make the line of the teeth so, when, of course, the above rule will not apply.

The tops of the lower set of teeth should be nearly in one plane, and as the lower front teeth are overlapped by the upper, it follows that the upper masticating teeth are in rather a higher plane than the six anterior upper teeth. The effect of this is to make the upper bicuspids a little shorter than the canines (see fig. 57), and if this is carried

FIG. 57.

out in the artificial teeth it helps us to avoid having a very full-looking mouth. Having mounted the upper teeth it is a matter of comparative ease to set up the lower teeth by them, but it is not so necessary to get the centre exact; indeed, it is rather better that the lower mesial line should not coincide with that of the upper. In nature it rarely does so.

Some irregularity in the setting of the teeth is admissible, especially in the lower, which can often by a little grinding at the sides be made to ride over one another in a very natural manner. This must be managed so that the two sides are symmetrically balanced in appearance without being exact copies of each other. But this method of giving a natural expression must be very judiciously and moderately used or the patient will not endure it, as he considers that if it is a defect needing regulation in the natural teeth it must needs be a blemish in the artificial teeth where we have the option of avoiding it.

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CHAPTER XIII.

ON THE POSSIBILITY OF MAKING PORCELAIN GUM BLOCKS IN THE ORDINARY DENTAL WORKROOM OF GENERAL PRACTICE.

The idea of being able to make continuous porcelain gum work has always exercised a sort of fascination for me, and I think the feeling is pretty general. When a pupil in the work-room I remember that we had an inclination in the same way, and some extraordinary blocks I helped to make there. One which we considered a great success we showed with pride to a medical friend who came in, when he burst out laughing. This so cooled our ardour, that I think it was the last we tried.

Many Dentists have had furnaces fitted up, but they have, I think, with few exceptions, abandoned the work. This shows that it is an ideal, and as a matter of fact no material has approached porcelain as a natural imitation of the gum.

The use of gum blocks is restricted and inconvenient in some ways. We require to be able to adapt the teeth to the bite or appearance individually, and the fact of having to move them in blocks is a serious disadvantage. What we want is to arrange the teeth and add the gum afterwards. It is to this aim that my efforts have been directed. When Mr. Fletcher brought out a gas furnace for the purpose my thoughts were directed to the subject, as I thought that the easy application of the means of heat would make the process practicable.

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I therefore determined about two years ago to make a few experiments, and procured some of the materials as supplied by the Americans for the purpose. Messrs. Lemale and Co. were also kind enough to supply me with some of their own body and gum, and not only so, but Mr. Fawsett, of their firm, with a kindness it is a pleasure to acknowledge, took much trouble in giving me information when I met with any difficulty, and also sent me several different gums to experiment with.

The first experiment was in a furnace, which we used to melt our gold with, a blacksmith's forge-bellows, and a coke fire, two blocks, one of American gum, the other of Lemale's, were placed in a muffle, which was covered over with coke and a white heat kept up for half an hour.

Lemale's gum had disappeared, the American was fairly fused. Convinced by this experiment that heat would melt the gum, I procured Fletcher's furnace, and having a set on hand which was very suitable for it, arranged the teeth for the work. To try the gas furnace first, a small block was put in, but, although heat enough to fuse this was got, the colour was quite spoilt, and it was some time before I found out that the cause of this was the construction of the muffle, which allowed the entrance of burnt gas. The slightest entrance of this I have since found always fatal.

If a muffle cracks so as to admit the entrance of gas, the best way is to fill up the crack with a little body. After this defect was remedied the pressure of the gas or the direction of the wind varied so that I could not get heat sufficient, and failure was the result. As the set could not wait it was sent out in the usual way.

After some further experience I had some success, sufficient to send out a couple of suction vulcanite uppers with all the eight teeth in a continuous block, but the process was very tedious. After the block was set up it had to be gradually put further and further into the furnace, taking three or four hours to reach the hottest place, and then to be kept there half an hour; then as the

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material contracted in fusing cracks took place; these had to be filled up after the piece was cooled down, and the process repeated, so that it took at least two days to make a block. One block, which was otherwise tolerably successful, was spoiled by using water, for the gum, which had been exposed in the workroom all night, and had presumably absorbed gas products, as the fresh gum was spoilt in colour.

The slightest amount of over-heat I found spoilt English teeth, first bleaching them, and then causing them to melt and lose shape. In this respect I found Ash's teeth stood better than Lemale's, but neither of them are to compare to American teeth in refractiveness.

But the difficulty which finally compelled me to abandon Fletcher's gas furnace was the impossibility of sufficiently annealing the pieces. The draught of cold air which took the place of the flame after the gas was turned out made nearly all the pieces inclined to craze; and, indeed, this difficulty I have not quite got over yet, although I think the means of doing so are sufficiently evident. One very curious cause of crazing occurred. Having run short of the American body I tried some American gum over Lemale's body, but Lemale's body melts at a lower temperature than the American gum, so that remaining melted after the gum was hardened its contraction at a different time has caused the American gum to crack in all directions.

A few months ago an article by Mr. Fletcher drew my attention to the subject again, and I determined to make a few experiments with his injector furnace. The first experiment was made by placing a small muffle upright in the furnace and making a lid or brim to it by surrounding it with plaster and sand, so as to rest on the edge of the furnace allowing vents as rays all round.

I found a great convenience in working this, that the state of the work is easily seen and the heat attained was quite sufficient, and I suggested this form to Mr. Fletcher, who had a furnace made to meet the suggestion. I found this furnace hardly give heat enough, the muffle being too large

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and shallow for the power of the flame; but the greatest cause of difficulty is, that the burnt gas naturally rises, surrounds the mouth of the muffle, and so gasses the work.

My next trial was to enter a small muffle in the injector furnace opposite the injector, bringing the muffle through the furnace, so as to touch the side next to the injector, but keeping it off the bottom so that the flame can play all around the muffle. I find in this little furnace that all the heat required can be obtained, about thirty-five minutes being all that is required to do the American gum, or twenty-five Lemale's.

After many experiments I have found it best not to dry and slowly heat the blocks, but to place them at once, whilst wet, in the furnace and heat up quickly, *i. e.* in ten minutes. The reason I cannot tell. I suggest that the steam going out through the surface of the gum keeps this cool the longest, so that the interior begins to contract first, but certainly I have had much less trouble with the blocks when placed in wet and quickly heated up than when carefully dried and slowly heated up, the cracking and curling up being in this case often very disappointing. This I consider one great step gained; instead of taking nearly all day after the block is made in slowly drying and heating, it can be done at once in thirty-five minutes. When there are more than three or four teeth I have found no certain cure for its cracking in contracting, and to ensure the cracks being small and coming in convenient places, so that you may successfully fill them up in the second treating, I think it expedient to divide the gum with a knife whilst moist, on each side of the laterals in an upper block of eight teeth. Even when a block of eight teeth is safely made and mounted in vulcanite, the inherent weakness of its shape is such that the mere handling in polishing is almost sure to cause flaws to appear. These, however, do not interfere with its strength, as from the number of pins in the teeth there is a superabundance of retaining power, and for strength the piece depends upon the vulcanite; nor will they be visible in wear, although they may

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appear as blemishes to the work in hand. I do not, however, propose the work generally for such large pieces, but rather imagine it may prove serviceable for the four incisor teeth, above or below, when these have to be replaced between natural canines where there is much recession of gum. The want of power to do this adequately for a young patient has often been felt by myself, and therefore, no doubt, by others.

Two other precautions have to be noticed before describing how a block is made. In the first place, as the whole block will contract in the fire, the teeth must be set rather farther apart than they are wished to be in the finished piece; and secondly, the gum and body become viscid whilst contracting, and draw the teeth out of their hold in the plaster. To meet the latter difficulty two methods may be adopted:—Either twist fine platina-wire loops around the pins of the teeth before investing them, so as to give them a firmer hold in the investment, or allow a slight ledge of plaster to come just over their edges in front. The first plan is rather troublesome to do; the latter has the disadvantage that the plaster sticks to the tooth when hot, and rather spoils the polish. I will now describe the method of making a block. First mount the teeth on a wax trial-plate, either to a correct bite or to the mouth, according to usual practice, only do not allow the wax to come up about the pins behind the teeth. To fix them to the trial-plate drop sufficient wax on them in front, but allow a little wax to project through between the divisions between the teeth, so as to strengthen the block, as the body is to take the place of the wax. Having mounted the teeth in the wax to the positions it is desired they should occupy, place the piece on the model and cut away all the wax behind the teeth except just so much as holds the teeth together and what covers the gum in front. The teeth and wax together now represent the desired block. Make an investment of equal parts silver sand and plaster, and set it so that the front teeth shall be horizontal and uppermost, and with a little plaster only continue the investment a little over the edges of the teeth. When set boil out

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the wax and the teeth are retained ready for the application of the body. The body is to be mixed with perfectly clean water, and the whole mould filled and modelled up to the fulness it is wished the future gum to be. A layer of gum is then to be added of about the thickness of a fourpenny-bit over the body, divisions made on each side of the lateral to control the cracking, and the piece placed at the far end of the muffle with the gum farthest in. Heat up slowly for five minutes, then put on full power so as to get to a white heat in ten minutes. Ten to fifteen minutes of moderate white heat is sufficient for Lemale's gum, and twenty to twenty-five minutes for the American. To gauge the heat is a nice point. No doubt eyes differ, but I find if I lose the outline of the piece in the heat there is danger of the gum running away altogether. Stop up the injection hole of the furnace with a small crucible and the escape by overturning the chimney, and give two hours for cooling. Then fill up the cracks with fresh body and gum and repeat the process.

FINIS.

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INDEX.

A

	PAGE
Additions and repairs, on	20
„ „ to add to a gold plate	21
„ „ how to take models for	20
„ „ to add single teeth to plate	22
„ „ to add flat backs	23
„ „ to repair a vulcanite piece	25
„ „ to add teeth to vulcanite pieces	27
„ „ to raise an old lower	28
„ „ to add vulcanite to old gold piece	29
„ „ to rectify warping in	89
Advantages of flat backs	148
„ tube-teeth	149
„ vulcanite teeth	148
Armadillos, functions of teeth of	xxiv
Arrangement of teeth with regard to personal beauty	164

B

Beauty, personal, arrangement of teeth with regard to	164
Bite, natural, in relation to suction uppers	61
„ „ leverage of	63
„ difficult case of	64
„ to get trial	162
Blowpipe, how to use the	159
Bony projection in palate	137

C

Cat, functions of teeth of	xxxviii
Cementum, function of	xxii

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PAGE

Clasps 82
„ general considerations of 83
„ for canines, in vulcanite pieces 78
„ for long canines 120
„ position for 84
„ grip of 85
„ round wisdom teeth 86
„ to solder on gold plates 117
„ where the natural teeth are continuous . . . 119
„ vulcanite 87
Continuous gum work, possibility of using . . . 174

D

Dasyure, function of teeth of xxv
Definition of the word "tooth" . . . . xi—xx
Dentine, function of xxii
Denture, fitting and covering ragged stumps . . . 47
„ method of packing difficult . . . 36, 52, 53
„ method of resetting old . . . 71, 76
„ with protruding upper natural front teeth . . 80
„ with few natural teeth remaining . . . 82
„ trial, to take bite with 162
Dentures, vulcanite and gold lower 38
„ „ partial 70
„ „ with one natural central remaining . . 70
„ „ with two natural centrals remaining . . 71
„ „ with four natural incisors remaining . . 74
„ „ with six natural front teeth remaining . . 76
„ „ with one natural tooth remaining . . 80
„ „ with clasps round canines . . . 78
„ „ to rectify warping in . . . 89
„ suction upper 57
„ complete 49
„ „ with springs 138
„ fees for temporary 89
„ large and small 90
„ for one front tooth 119
„ suction, best form of upper jaw for . . . 134
„ manner of relieving when bony projection in palate . 137
„ gold, right central and left lateral . . . 120
„ „ for one or two teeth 120
„ „ suction for one or two teeth . . . 122

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PAGE

Dentures, gold, in shape of letter H 124
„ „ suction 126
Dog, functions of teeth of xxxix

E

Echidna, function of teeth of xxiii
Elephant, „ „ xxxiii
Enamel, „ „ xxii
Expression, arrangement of teeth in regard to . . 170

F

Fees for temporary dentures 88
„ relative to gold and vulcanite pieces . . . 48
Flasks, to close 72
Functions of cementum xxii
„ dentine xxii
„ enamel xxii
„ masseter muscle xxii
„ pterygoid muscle xxii
„ temporal muscle xxii
„ teeth of mammalia . . . xx—xl
„ „ man . . . . xl—lii
„ „ armadillo . . . xxiv
„ „ cat xxxviii
„ „ dasyure xxv
„ „ dog xxxix
„ „ echidna xxiii
„ „ elephant xxxiii
„ „ guinea-pig . . . xxvii
„ „ galeopithecus . . . xxxix
„ „ hedgehog . . . xxviii
„ „ hyena xxix
„ „ horse xxxiv
„ „ hippopotamus . . . xxxviii
„ „ hog xxxviii
„ „ kangaroo xxv
„ „ mole xxx
„ „ narwhal xxx
„ „ ornithorynchus . . . xxiv

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PAGE

Functions of teeth of rodents xxvi
„ „ rhinoceros xxxiv
„ „ ruminants xxxv
„ „ sloth xxiv
„ „ sheep xxxvii

G

Galeopithecus, functions of teeth of xxxix
General considerations concerning lowers . . . 42
Gold work 105
„ plate, full 110
„ „ H-shaped 124
„ „ manner of relieving pressure in palate of . . 137
„ „ method of mounting teeth on . . . 148
„ „ number of dies required for . . . 112
„ „ partial 110
„ „ to attach vulcanite teeth to . . . 161
„ „ to cast for 113
„ „ to cut out 109
„ „ to finish striking up 114
„ „ to solder clasps on 117
„ „ to strike up 110
„ „ warping of 115
„ „ „ to avoid 116
„ „ with deep palate 111
„ uppers, small 119
„ „ „ for one or two teeth . . . 122
„ „ suction 126
„ „ „ for one or two teeth . . . 122
„ „ „ for masticating teeth only . . 134
„ work, general considerations concerning . . . 105
Gum work, continuous, possibility of using . . . 174

H

Hedgehog's teeth, functions of xxviii
Hippopotamus' teeth, „ xxxviii
Hog's teeth, „ xl
Horse's teeth, „ xxxiv
Human teeth, „ xl
Hyena's teeth, „ xxix

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I

PAGE

Illustration of hyena's tooth xxv
„ case of two natural incisors remaining . . 73
„ „ four „ „ . . 75
„ „ small gold piece 120
„ „ „ suction piece . . . 122
„ how to tie in regulation plate . . . 5
„ „ „ plate to canine 11
„ „ add to old gold plate . . . 21
„ „ repair vulcanite lower . . . 25
„ „ add vulcanite to gold plate . . 30, 31
„ „ pack difficult upper . . 53, 55, 68
„ „ „ lower . . 45, 46
„ „ clasp continuous teeth . . . 119
„ H-shaped gold plate . . . 124, 125
„ large and small mouths 90
„ leverage of bite with regard to suction pieces . . 63
„ models of twins 14
„ model of cleft palate . . . 34, 35
„ „ to pack on . . . 36, 37
„ „ of deep mouth (section) . . . 128
„ „ of round „ . . . 129
„ „ of flat „ . . 130, 131
„ „ of full alveolar border (section) . . 132
„ „ suction piece failed 133
„ „ to show bony projection in palate . . 137
„ open mouth 171
„ pivoting instruments 96
„ pivot teeth 102
„ „ tooth 99
„ principle of suction uppers . . . 59
„ „ adding clasps . . 79, 84, 85, 119, 120
„ regulation case 3, 4, 9, 17, 18
„ „ frame 13
„ section of old piece reset 29
„ side view of teeth 173
„ smiling mouth 172
„ strengthener for lower vulcanite piece . . 40
„ „ upper „ . . 41
„ „ piece with back teeth only . . 75
„ suction upper, with difficult bite . . . 65
„ to show drop of plate . . . 84, 85
Illustrations.—Action of kangaroo's teeth . . . xxv
„ „ leopard's „ . . . xxv

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PAGE

Illustrations.—Action of mole's „ . . xxvii
„ „ guinea-pig's „ . . . xxvii
„ „ hedgehog's „ . . . xxv
„ „ sheep's „ . . xxxvii

K

Kangaroo, functions of teeth of . xxv

L

Lower pieces, general considerations concerning . . 42
„ small, with isolated teeth . . . 43
„ strengtheners for . . . 40
„ with bar behind front teeth . . . 43
„ with incisors and molars 44
„ „ „ and springs . . 45
„ with undercuts 56

M

Mammalian teeth, functions of . . xx—xl
Method of mounting tube-teeth . . . 150
„ „ pins for tube-teeth . . 152
„ making upper when natural incisors protrude . . 80
„ packing a difficult case 36
„ „ „ suction case . . 52, 52
„ „ suction upper with front teeth on stumps . 65
„ resetting old piece 71, 76
Methods of mounting teeth on gold plates . . . 147
Model, to take, for repairs and additions . . . 20
„ „ overhanging teeth 87
Mole, functions of teeth of xxx
Mucal base 73
Muscle, masseter, function of xxii
„ pterygoid xxii

N

Narwhal, functions of teeth of xxx

Digitized by Google

O

PAGE
Ornithorynchus, teeth of xxiv

P

Palate, bony, projection in 137
Pattern, to make a lead 106
Pivoting teeth 94
„ instruments for 96
„ results of 125 cases 103
„ suitable 97
Principles of clasps generally considered 84
„ „ for upper canines 78
„ leverage or bite in suction cases . . . 62
„ suction in upper pieces 59

R

Regulating plates, on 1
„ case of twins 14
„ case of underhung bite . . . 17
„ retaining caps 19
„ time between visits 7
„ to bring in outstanding incisor . . . 18
„ to draw teeth back 4
„ to make space for canines . . . 13
„ to push teeth forward . . . 11
„ to tie to teeth in mouth . . 5, 11
Repairs and additions 20
„ „ to add to gold plate . . . 21
„ „ „ single tooth . . . 22
„ „ „ flat tooth . . . 23
„ „ „ to vulcanite . . . 27
„ „ „ vulcanite to gold . . . 29
„ „ to raise an old lower . . . 28
„ „ to repair vulcanite 25
„ „ to take model for 20
„ „ to rectify warping in . . . 89
Rhinoceros, functions of teeth of xxxiv
Rodents „ „ xxvi
Ruminants „ „ xxxv

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S

	PAGE
Sets, full	49
„ if two are necessary?	144
„ with springs	138
„ „ difficulties with	143
Sheep, functions of teeth of	xxxvii
Sloth „ „	xxiv
Solder, to, flat teeth	159
„ general directions	160
„ on sand	117
„ pins for tube-teeth	153
„ swivels	139
Special tray, to make	77
Speech, improved case of	50
Springs, abandonment of	49
„ sets with	138
„ thrust of	142
„ to put on, to set	145
Strengtheners for vulcanite lowers	39
„ „ pieces	37
„ „ uppers	41
Suction uppers	57
„ principles of, considered	58
„ pieces classified	59
„ method of packing	65
Sulphur for tube-teeth	156
Swivels, position of	142
„ to mount	141

T

Taste in mounting teeth, education of	166
Teeth, choice of, with regard to expression	168
„ considerations in choosing sort of	148
„ features expressive of character	167
„ flat, to back	156
„ „ mount	157
„ „ solder	159
„ of different makers, remarks on	165
„ vulcanite, to attach to gold plate	161
„ advantages of flat	148
„ „ tube	149
„ „ vulcanite	148

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PAGE

Teeth, to clasp, when continuous 119
„ to mount 147
„ tube, to fine fit 155
„ „ mount pins for 152
„ „ „ quickly 150
„ „ to let down 151
„ mammalian . . . . . xxiii—xxxix
„ human xl
Tooth, definition of . . . . . xi—xx

U

Upper jaw, best form of, for suction pieces . . . 134
„ flat 130
„ Gothic arched 132
„ Roman arched 128
„ semi-circular 129
„ semi-elliptical 127
„ shapes of, classified 127

V

Vulcanite and gold lowers 38
„ „ question of fees for 48
„ dentures, on 34
„ pieces, to file up and finish 91
„ piece covering and fitting ragged stumps . . 47
„ teeth, to get bite in mouth with . . . 161
„ to know when enough is in flask . . . 72
„ uppers, clasps for canines in 78
„ „ complete, with exception of one central . . 70
„ „ „ „ two centrals . . 72
„ „ „ „ four incisors . . 74
„ „ „ „ six front teeth . . 76
„ „ partial 70
„ „ with one natural tooth remaining . . 80

W

Walrus, functions of teeth of xxxi

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Adams (W.) on Clubfoot, 11
——— on Contraction of the Fingers, 11
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Alexander's Displacements of the Uterus, 6
Allan's Outlines of Infectious Diseases, 7
Allingham on Diseases of the Rectum, 14
Anatomical Remembrancer, 3
Balfour's Diseases of the Heart and Aorta, 9
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Barnes (R.) on Obstetric Operations, 5
——— on Diseases of Women, 5
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Fayrer's Climate and Fevers of India, 7
Fenwick (E. H.), Electric Illumination of Bladder, 14
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——— Medical Diagnosis, 8
——— Outlines of Medical Treatment, 8
——— The Saliva as a Test, 8
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——— Manual of Diseases of Nervous System, 9
——— Medical Ophthalmoscopy, 9
——— Pseudo-Hypertrophic Muscular Paralysis, 9
Granville on Gout, 9
——— on Nerve Vibration and Excitation, 9
Guy's Hospital Formulæ, 2
——— Reports, 2
Habershon's Diseases of the Abdomen, 9
——— Liver, 9
——— Stomach, 9
——— Pneumogastric Nerve, 9
Hardwicke's Medical Education, 14
Harley on Diseases of the Liver, 9
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Robinson (Tom) on Eczema, 14
——— on Syphilis, 14
Robinson (W.) on Endemic Goitre or Thyreocele, 12
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——— Handbook of ditto, 9
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——— Lithotomy and Lithotrity, 14
——— Stricture of the Urethra, 14
——— Suprapubic Operation, 14
——— Surgery of the Urinary Organs, 14
——— Tumours of the Bladder, 14
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——— How to use a Galvanic Battery, 10
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Tirard's Prescriber's Pharmacopœia, 7
Tomes' (C. S.) Dental Anatomy, 12
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